ORDNANCE

LAND · SEA · AIR

On the Beam

NOVEMBER-DECEMBER 1955

Machines high-precision bearing races in 30 to 60 seconds

with TIMKEN® bearings on the spindle

THIS Acme-Gridley CHUCK-MATIC machines the races of high-precision bearings from 4″ to 8″ in diameter. And it does it in 30 to 60 seconds, operating at speeds and feeds as fast as carbide tools can take. The spindle bearings must have high precision. And must keep that precision at high speeds, under heavy combination loads. That's why National Acme specified Timken® precision bearings for the spindle.

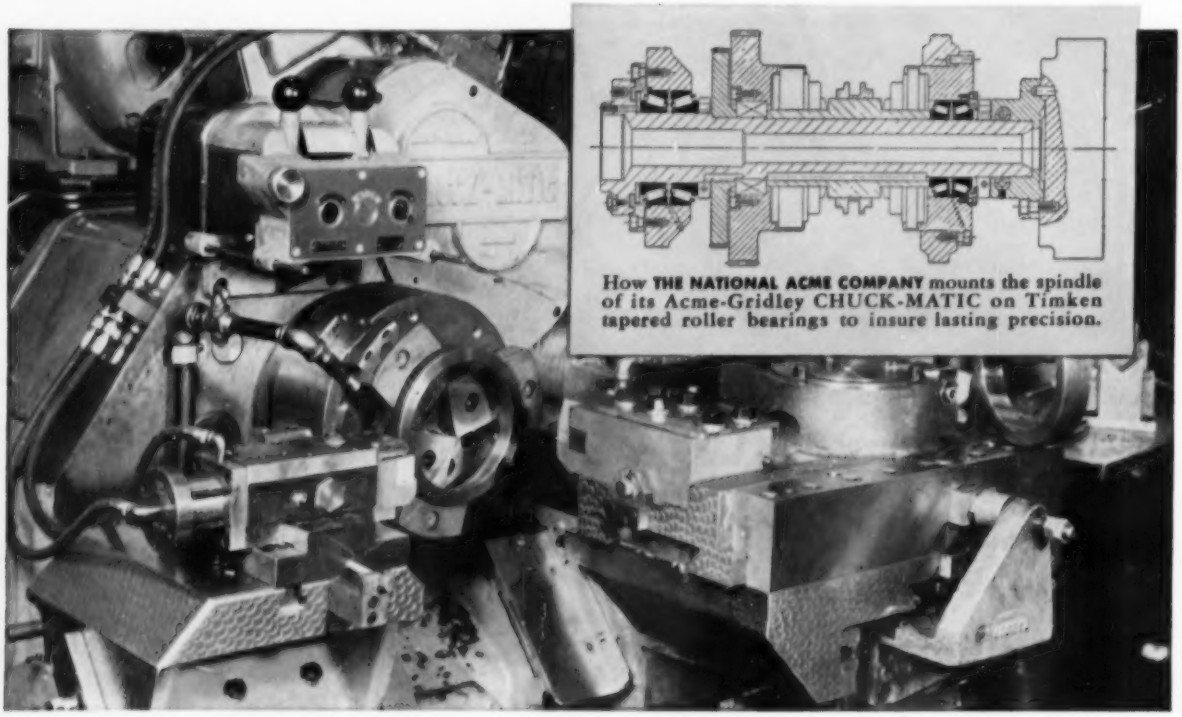
The tapered design of Timken bearings lets them take radial and thrust loads in any combination. The spindle is held in rigid alignment. End play is eliminated. These factors plus the extreme accuracy of Timken bearings assure precision machining at all times.

Full line contact between the rollers and races of Timken bearings gives them extra capacity to carry the loads of the heavy, high-speed cuts. And since Timken bearings on the spindle normally last the life of the CHUCK-MATIC itself, maintenance is reduced.

Power is saved in the CHUCK-MATIC because Timken bearings practically eliminate friction. They are geometrically designed to give true rolling motion and they are precision manufactured to live up to their design. And to get the quality of steel to meet our exacting specifications, we make our own. No other U. S. bearing manufacturer takes this extra quality control.

Specify Timken bearings for the machinery you build or buy. Always look for the trade-mark "Timken" on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



How **THE NATIONAL ACME COMPANY** mounts the spindle of its Acme-Gridley CHUCK-MATIC on Timken tapered roller bearings to insure lasting precision.

REVOLUTIONARY BUCYRUS PLANT HELPS HOLD DOWN RISING COSTS

At a new plant in Bucyrus, Ohio, the Timken Company has substantially reduced the cost of tapered roller bearings by: 1) producing these bearings under a new system of extreme mechanization; 2) standardizing on 15 bearing sizes with the widest applications throughout industry. Manufacturers can take advantage of these lower costs by redesigning applications to use these Bucyrus sizes. And as more switch to Bucyrus bearings, production costs can drop still further, meaning even lower costs to you.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ◎ AND THRUST →◎← LOADS OR ANY COMBINATION

ORDNANCE

LAND · SEA · AIR

The Magazine of Scientific and Industrial Preparedness Now in Its 36th Year

VOL. XL NOVEMBER-DECEMBER 1955 NO. 213

The Cover.—Designed to increase the strength of telemetering signals received from airborne vehicles during flight tests conducted by the Sandia Corporation at the Salton Sea Test Base, California, this device, known as Apota (automatic positioning of telemetering antenna), is capable of a 20-decibel gain in received signals.

Previous Editors

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Brig. Gen. R. H. Somers 1922-1925

Maj. Gen. R. L. Maxwell 1925-1926

Col. C. R. Baxter 1926-1929

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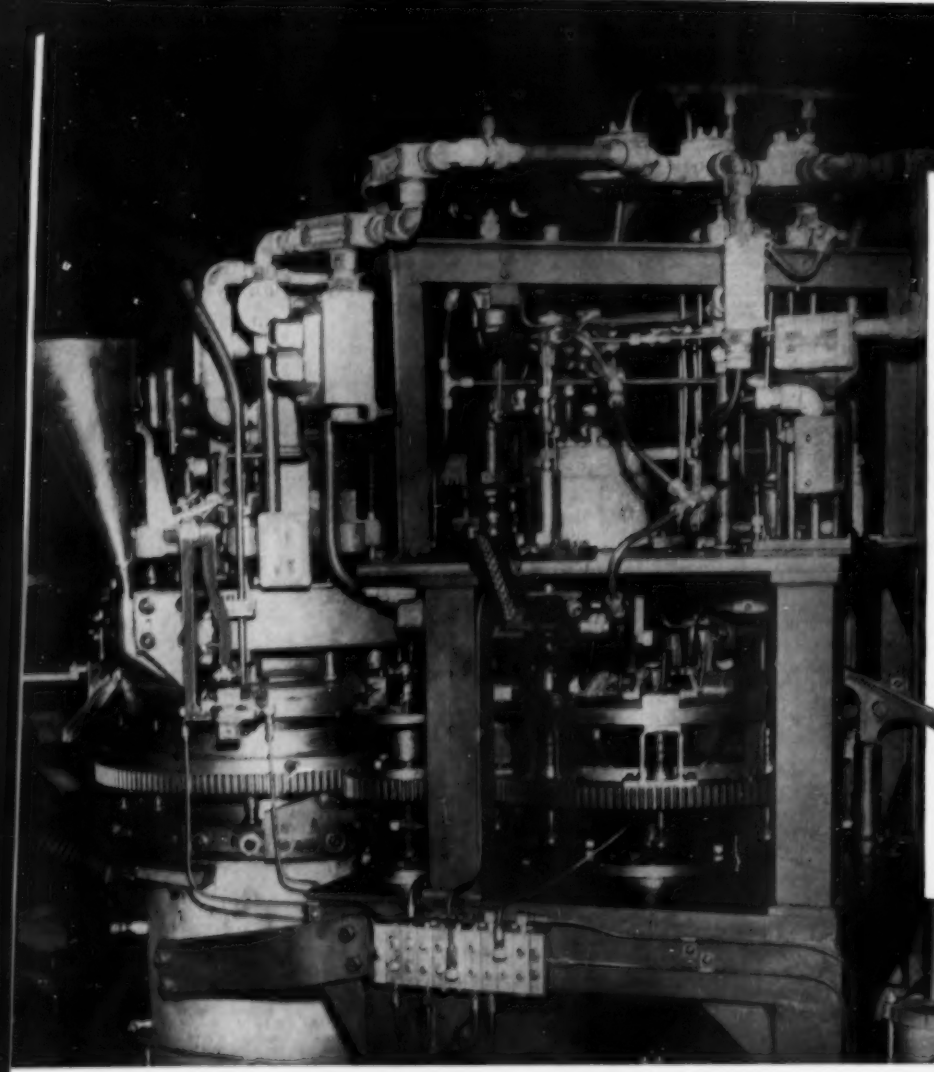

20 mm. booster charges are automatically loaded and assembled by the Stokes machine shown at left. Other Stokes equipment assembles these charges into complete components, as shown in phantom above.

NEW Stokes ordnance machine triples fuze production

Completely automatic loading unit eliminates all manual operations for greater safety, increased economy

In setting up its 20 mm. fuze production line, one of the country's largest arsenals had two requirements: (1) the highest possible degree of automatic operation and, (2) maximum safety. Stokes engineers fulfilled both objectives with a new multi-unit machine that automatically performs *every* operation and inspection, from feeding empty booster cups to assembly of complete fuze components.

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The high degree of automatic operation achieved in this equipment is typical of Stokes' skill in the design of automatic production machinery. We will be glad to apply our experience in this field to your problems whether in ordnance or other production processes.

F. J. Stokes Machine Company, Philadelphia 20, Pa.

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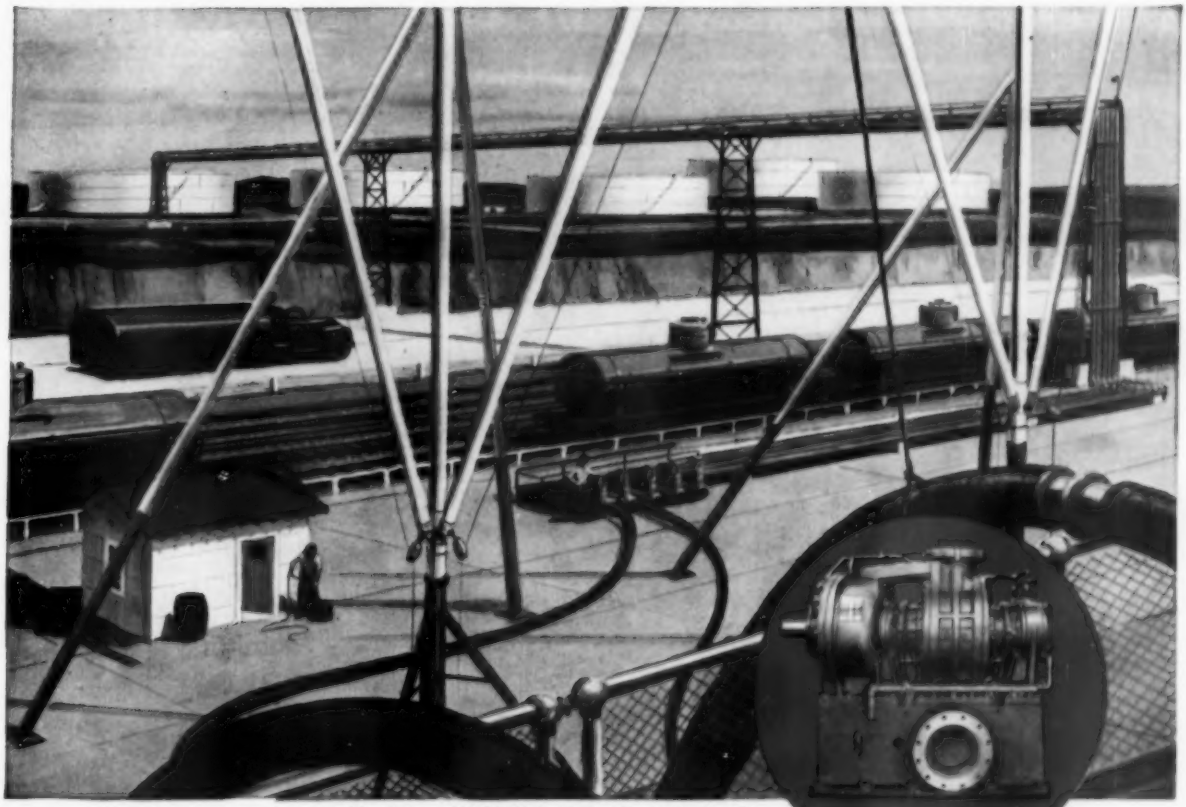

The Kinney HQAC Main Cargo Pump for handling petroleum products, sea water ballast, molasses, etc.

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All of these jobs: *drawing a glass of water . . . transferring a tanker load of crude oil . . . transporting a carload of glucose or molasses . . . racking off barrels of beer...injecting metered additives into beauty lotions or chemical compounds . . .* all have one thing in common. YOU MUST HAVE A PUMP TO DO THEM – *ECONOMICALLY.*

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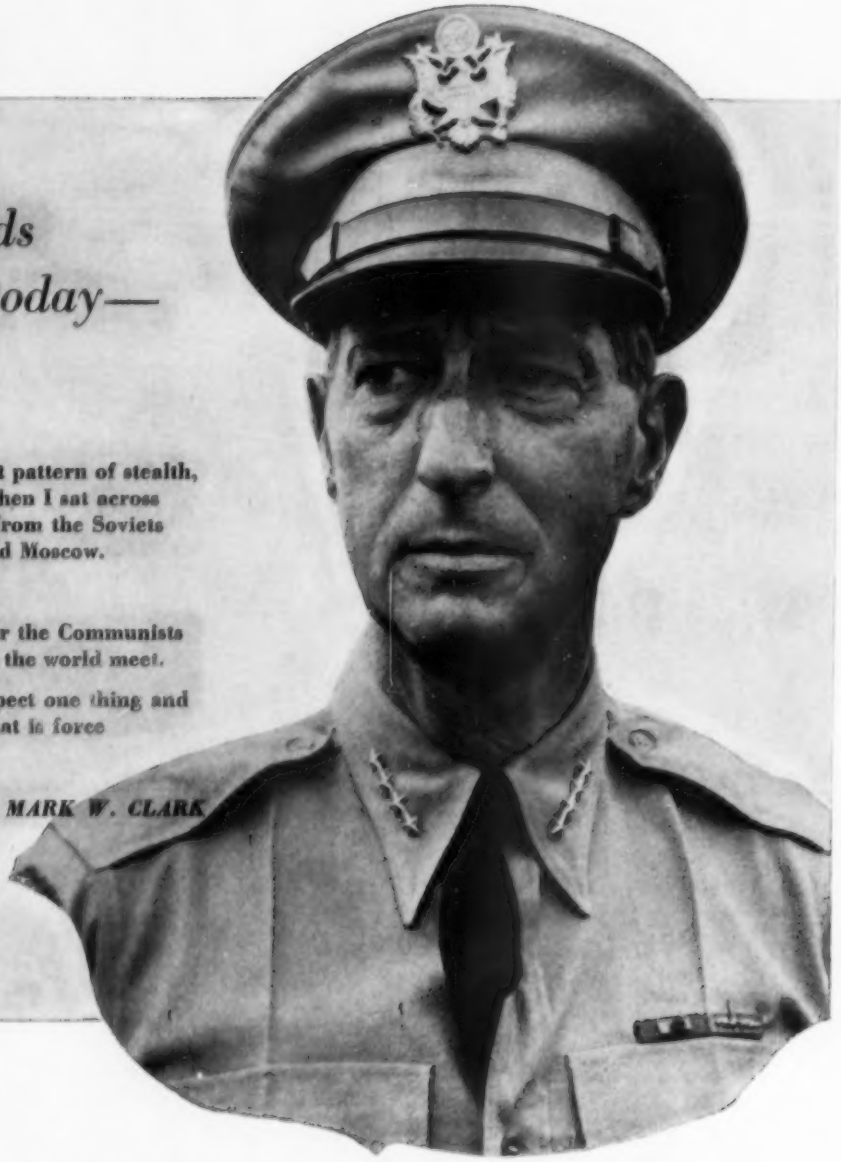

"I saw the Communist pattern of stealth, treachery and lying when I sat across the conference table from the Soviets in Vienna, London and Moscow.

"I saw it in Korea.

"It is present wherever the Communists and the free people of the world meet.

"The Communists respect one thing and one thing only, and that is force and determination."

—*GENERAL MARK W. CLARK*

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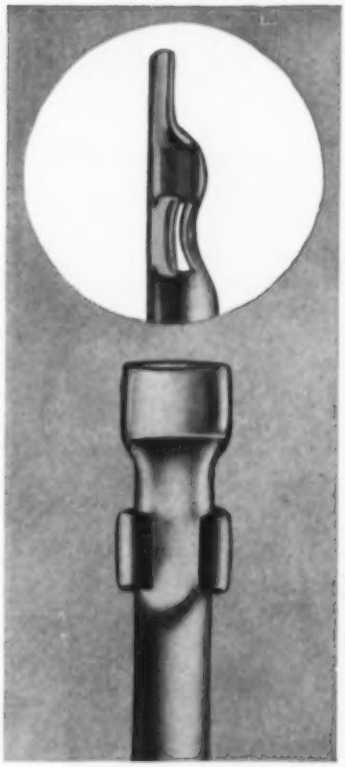
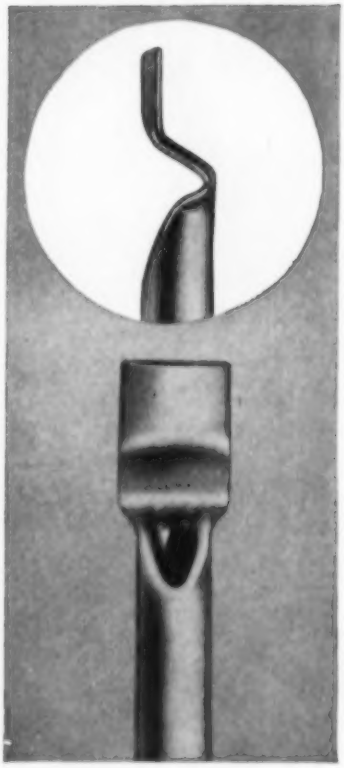


Problem: Customer submitted specification for vent tube, as shown above, for use inside gasoline filler tube. Problem was to remove the possibility of gasoline entering two side vents as gas tank was filled. The Bundy engineers showed customer the way to big fabrication savings.



Solution: Improved design suggested by Bundy engineers completely protects vent from gasoline entry by baffle deflection. Moreover, this part requires just two simple operations: one to flatten end and pierce tube simultaneously, the other to put a double bend in flattened end.

Bundyweld starts as a single strip of copper-coated steel. Then it's

. . . continuously rolled twice around laterally into a tube of uniform thickness, and passed

through a furnace. Copper coating fuses with steel. Result . . .

Bundyweld, double-walled and brazed through 360° of wall contact

NOTE the exclusive Bundy-developed beveled edges, which afford a smoother joint, absence of bead, and less chance for any leakage.

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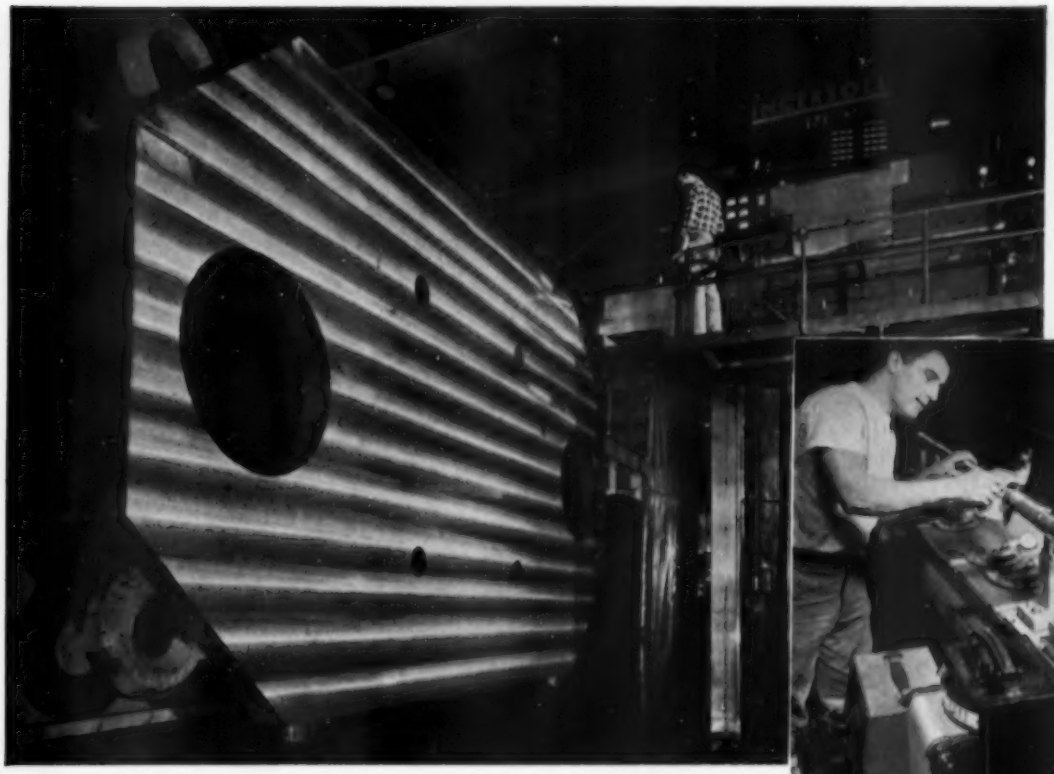

Before you decide who's going to build it...

You're wise to get a bid from BLISS

Mass and precision: *At left*, a large horizontal boring mill at Bliss' Canton plant is used to finish machine 200-ton weldment for 25,000 ton press. *Directly above*, an electronic recording gage checks three separate tapers in the chambers of barrels for 20 mm machine guns. Tolerances are held to 0.002".

The reasons are quickly summed up: flexible manufacturing facilities backed by long experience and a record of successful performance on past contracts, both government and civilian. Whether you want a few hundred-ton units or many thousands of small parts weighing a few pounds each, be sure to check with Bliss before you buy.

BLISS offers you... the experience gained in the production of equipment like

• aircraft carrier catapults • 20 mm machine guns • gun mounts • ammunition machinery • torpedoes • shells • tank cupolas

plus facilities that include • 11 U.S. plants—two million square feet of floor space and, at present day values, about a $44,000,000-inventory of metalworking tools • Four foundries pouring steel, iron and Meehanite castings, including the largest and heaviest types • Two welding departments with equipment to cut out, weld, preheat and anneal weldments weighing hundreds of tons.

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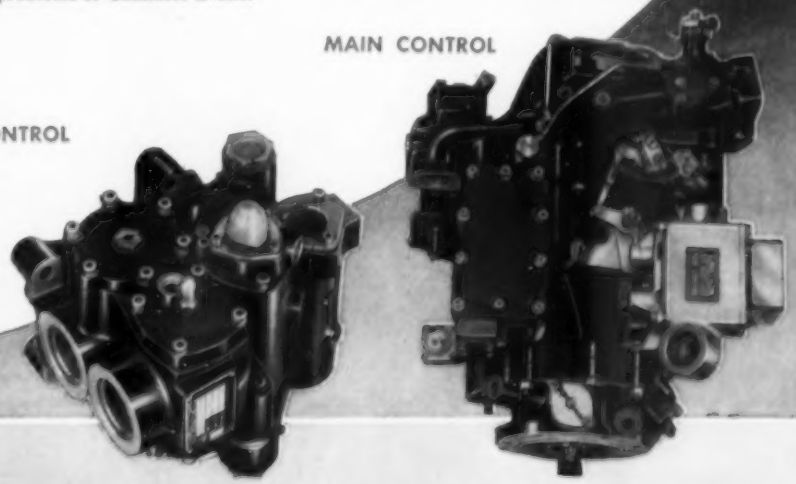
MAIN CONTROL

AFTERBURNER CONTROL



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Now, as in 1908, America steps out in high-spirited pride on wheels by Kelsey-Hayes. Behind their striking beauty and stalwart performance is the accumulated knowledge and skills of 46 years of superior wheel-crafting.

We are proud of the continuing contribution made through the years to the motoring safety and dependability of the cars that roll on wheels by the *Kelsey-Hayes Wheel Co., Detroit 32, Mich.*

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Every 3 seconds—a heated bar with this Magnethermic 10,000 cycle Induction Heater

This 10,000 cycle unit preheats 1" steel bars to 2300 degrees for upsetting at rate of one every 3 seconds or over 1,000 per hour.

Induction preheating for forging or extrusion has many advantages: speed, economy, cleanliness, close control, adaptability, increased die life and attractive working conditions.

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Magnethermic makes induction heaters only, 60 through 10,000 cycles, and can give you experienced guidance on selecting the best frequency for your heating job.

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Just as in colonial days did superb craftsmanship make the signature *"Paul Revere"* the symbol of quality, so in present day industry has its quality-control made the name Rheem the symbol of reliability.

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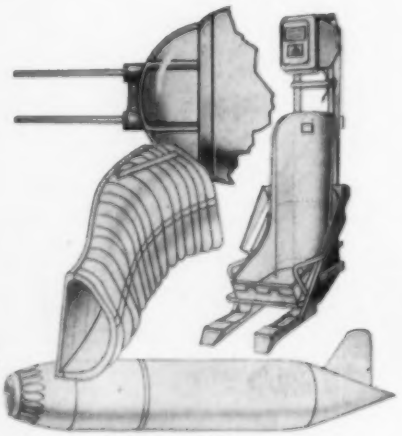

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Each of these insignia represents a unit world-famous for the most vital of military virtues – dependability. Military reputations are not easily won, and that is why the Olin Mathieson Chemical Corporation is so proud that its products, brands and branches have been on permanent duty with our Armed Forces since the days of the Sharps rifle. The complexities of national security and of the materials for defense have increased enormously since those days, but the basic requirement of dependability remains constant. Any of the insignia *below* can be called to duty today, with the knowledge and confidence that the varied products they represent have served the Armed Forces with distinction.

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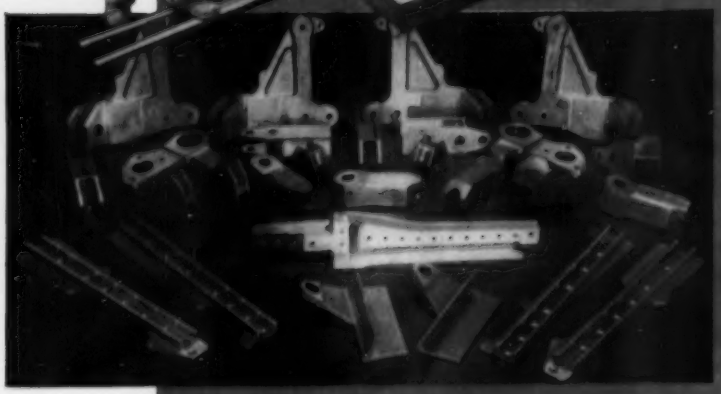

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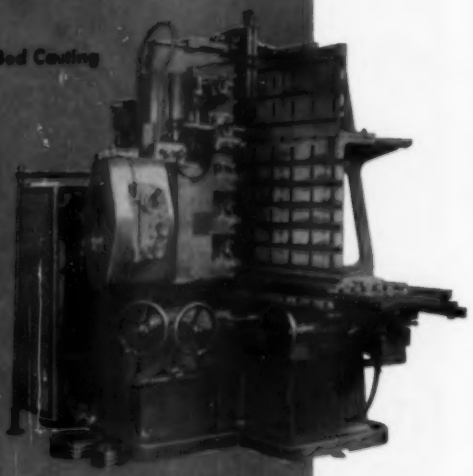
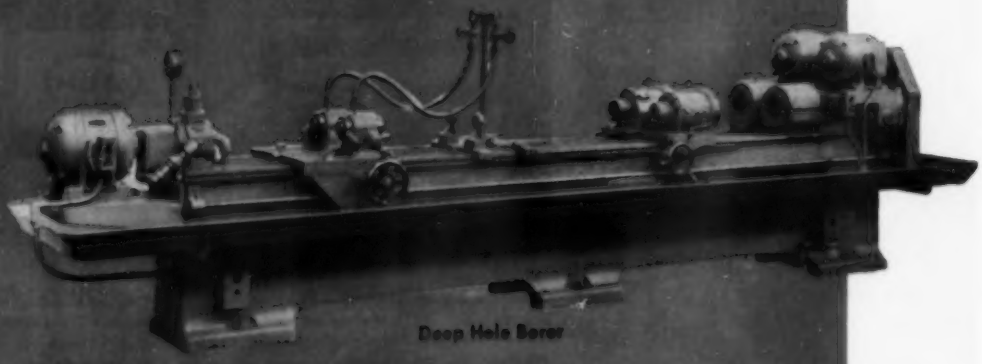


Keller Machine



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Manufacturer of printing presses for 150 years, of heavy ordnance and components since 1847—during the last fifteen years HOE has cooperated with thirty-odd leading manufacturers by making castings, machine parts, subassemblies and many complete machines.

HOE is equipped to handle similar work for you – and during the next two years HOE's facilities will be augmented by a further investment of $1,200,000 in additional machine tools.

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Hunting—and the Man from Sleepy Hollow

"We descried a herd of buffalo about two miles distant, scattered apart and quietly grazing near a small strip of trees and bushes. Taking a wide circuit, we moved slowly and cautiously . . . then galloping along parallel, I singled out a buffalo and by a fortunate shot brought it down on the spot"—so wrote author Washington Irving of a hunting trip out West.

Yes, the hand that immortalized Rip Van Winkle and Ichabod Crane felt right at home around a rifle stock. Whenever Irving looked for relaxation, we're told he would take his gun and track the forests of Sleepy Hollow for fox, pheasant, duck or deer. Sometimes he made a kill—sometimes he didn't. But losing a quarry never spoiled his day. Hunting thrills and the healthy outdoors gave him a new outlook . . . brought him pleasure and sent him home refreshed.

Since pre-Revolutionary days, Americans have answered the call of hunting and the outdoor life. It's a sport that challenges wits, reflexes, stamina and skill. Equally important, hunting builds self-reliance and endurance, helping to keep our nation strong.

Today, the great American tradition of hunting can be perpetuated only by thoughtful preservation of wildlife. Throughout the country hunting associations are cooperating with public agencies to promote proper conservation. Do your part in preserving this heritage—join or support one of these groups now. E. I. du Pont de Nemours & Co. (Inc.), Explosives Department, Wilmington 98, Delaware.

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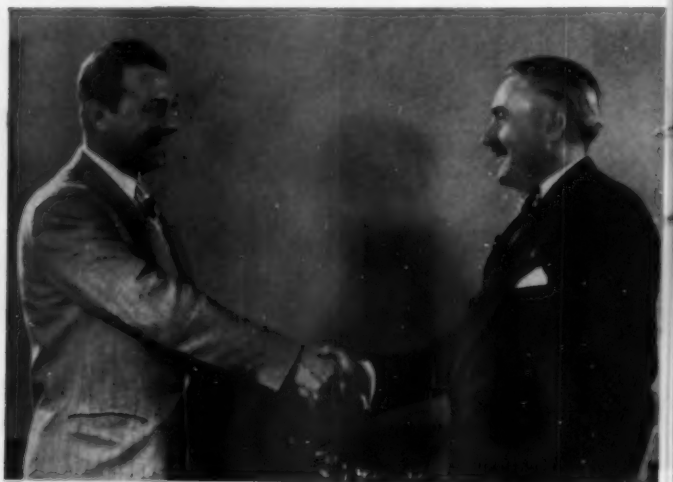

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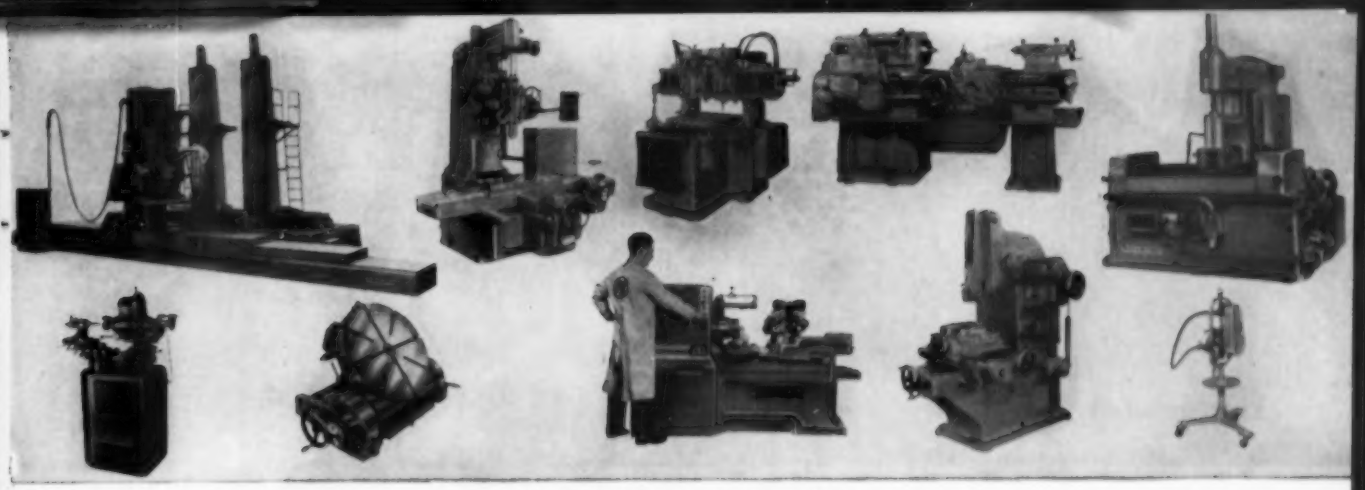

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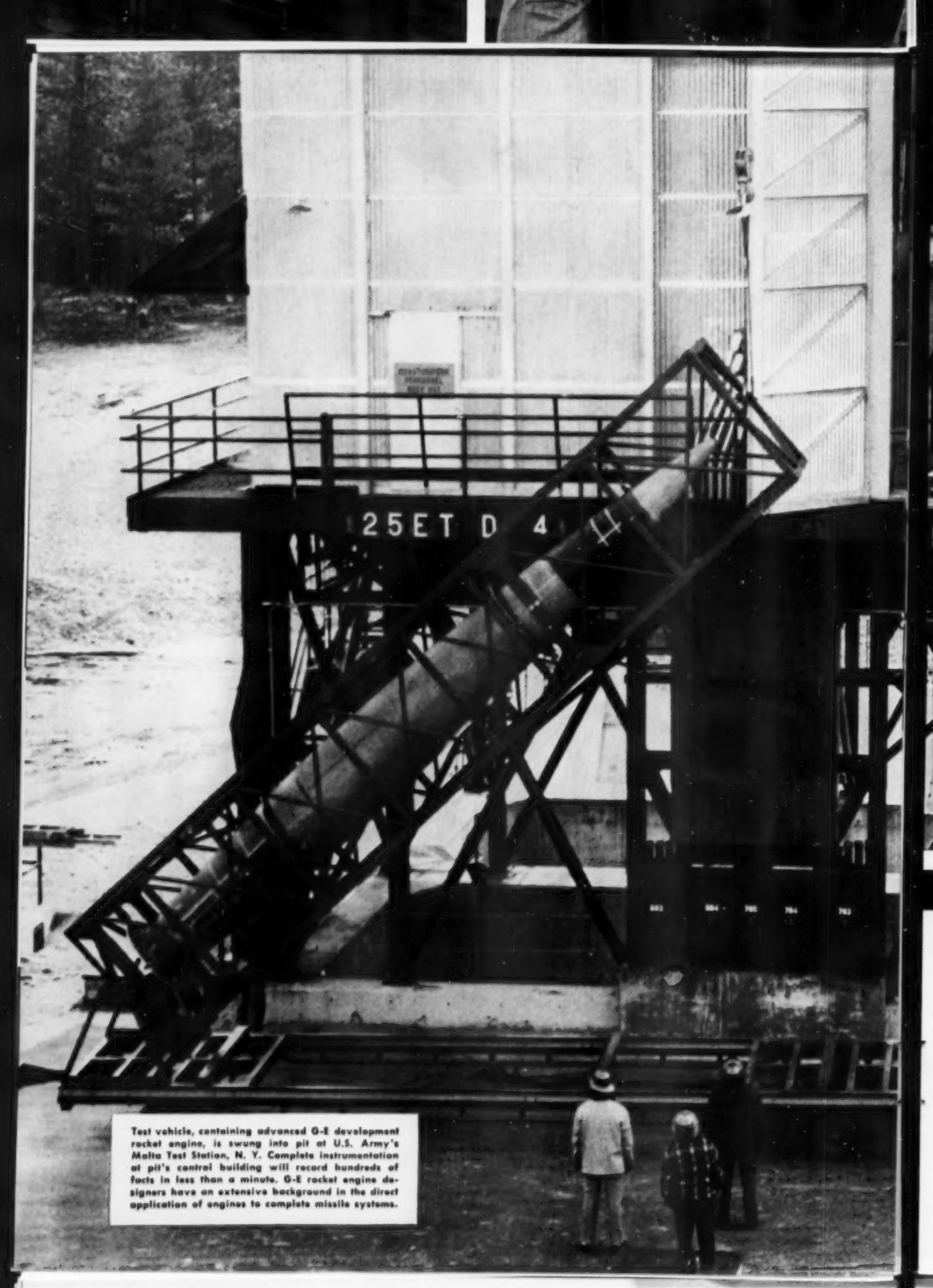

Test vehicle, containing advanced G-E development rocket engine, is swung into pit at U.S. Army's Malta Test Station, N. Y. Complete instrumentation at pit's control building will record hundreds of facts in less than a minute. G-E rocket engine designers have an extensive background in the direct application of engines to complete missile systems.

ROCKET ENGINE PROGRESS AT GENERAL ELECTRIC

Weight Cut More Than 50% In NEW G-E Rocket Thrust Chamber

General Electric has tested an advanced rocket thrust chamber which weighs 50% less per pound of thrust than previous chambers of similar design. This marks another step in General Electric's continuing progress in developing better engines for the aviation industry. The significant weight reduction was achieved without compromising performance and reliability characteristics typical of G-E engines.

General Electric has been cutting rocket engine weight ever since G-E engineers ran the first U.S. tests on German V-2 engines in 1947. For example, the use of lighter materials and the transfer of start-up components from missile to ground are two weight reduction methods G.E. has pioneered. Experiments with new materials and new means of fabrication promise even more improvements on future engines.

Advanced Facilities Speed New Rocket Engine Development

Today, General Electric is able to undertake a wide variety of rocket engine development work. The Company's rocket team, as an integral part of the Aircraft Gas Turbine Development Department, has access to the nation's most advanced privately-owned aircraft engine development facilities, as well as support from other G-E labs.

These facilities spell more and faster development progress for rocket engine programs and they underline G.E.'s increased capability for developing a wide range of rocket systems, subassemblies and components. To find out how General Electric can meet your specific rocket engine needs, contact a G-E Aircraft Specialist through your nearest G-E Apparatus Sales Office. 234-2

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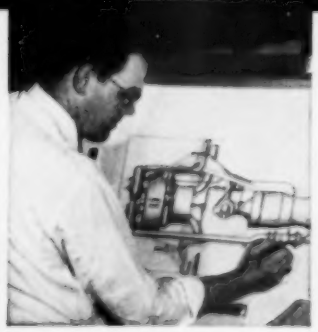
ADVANCED ROCKET ENGINE DEVELOPMENT ACTIVITIES AT G.E.



OVER EIGHT YEARS' EXPERIENCE PER MAN is the record of G-E rocket engineers. This experience is now paying off in advanced powerplant designs under development.

STRONGER, LIGHTER ALLOYS being developed at G.E. will give rocket engines greater reliability, higher performance. A technician at the Company's Materials Laboratory checks a new alloy for tensile strength.

PREDICTING ADVANCED G-E ENGINE PERFORMANCE with electronic computer cuts development time, enables G-E engineers to ascertain optimum design characteristics of engines still on the drawing board.

G-E Facilities Available to Support Rocket Engine Programs:

- Component Development Laboratory
- Materials Laboratory
- Research Laboratory
- General Engineering Laboratory
- Combustion Laboratory
- Metals and Ceramics Laboratory

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CONTINENTAL J69

Compact, easily serviced. 920 lbs. thrust. Single-stage centrifugal compressor, single annular combustor, single-stage turbine; hollow-shaft fuel introduction provides excellent atomization and is non-clogging—eliminates need of high-pressure fuel system.

"The era of jet-powered business aircraft . . . undoubtedly is just over the horizon." . . . This is the conclusion* reached by Herb Fisher, Chief, Aviation Development Division, The Port of New York Authority, after flying the MS 760 twin jet executive transport which Beech Aircraft Corp. has been demonstrating in America this summer. U. S. version of the ship will be powered by Continental J69, raising the service ceiling to 35,500 feet and maximum speed to 410 mph. . . . This pioneer twin jet transport marks an important addition to the list of applications for which the J69 is admirably suited in performance characteristics, and design. The engine is now in production at C. A. E.

*See "Executive Pilot's Report: MS 760", Skyways, August 1955, P. 12.

CAREERS FOR ENGINEERS

Continental Aviation & Engineering Corp. has openings for technically-trained men. Engineers interested in positions with almost unlimited opportunity for advancement, in this new and challenging industry, are invited to write for information.

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ATOMIC ENERGY

FULL-SCALE POWER PLANT

The United States' first full-scale nuclear power plant for the generation of electricity will be fueled by 12 tons of natural uranium in the form of a "blanket" that surrounds some 115 pounds of highly enriched uranium "seed." These details about the reactor core were revealed at the International Conference on the Peaceful Uses of Atomic Energy, Geneva, Switzerland.

Other previously classified details of the pressurized water reactor power plant, which will be located at Shippingport, Pa., near Pittsburgh, were disclosed in a technical paper coauthored by representatives of the Westinghouse Electric Corporation, Duquesne Light Company, and the United States Atomic Energy Commission.

The revolutionary power plant is part of the AEC's program to develop industrial nuclear power. The plant will contain a 100,000-kilowatt turbine generator which will begin to deliver at least 60,000 kilowatts of electricity to homes and industry in the Pittsburgh area in 1957.

Westinghouse, under contract to the AEC, is designing and building the reactor for the plant. Duquesne Light will build the electric-generating portion of the plant and will operate the entire plant after its completion.

Most of the power from the reactor will come from the fissioning, or splitting, of uranium 235 atoms. Some power will even come from the splitting by high-speed neutrons of normally nonfissionable uranium 238.

A substantial fraction of the power will come from splitting atoms of plutonium—a fissionable product of reacting uranium 238. At the start of the reactor's operation, approximately eight-tenths of a plutonium atom will be formed for each atom of U-235 that is fissioned. The amount of plutonium increases during the lifetime of the reactor.

It was reported that the new reactor will have twenty-four control rods made of hafnium metal which was selected because it readily absorbs neutrons and thus can retard the atom-splitting, heat-producing process.

The vessel which will hold the reactor will have an over-all height of thirty-three feet. It will be cylindrical in shape and will have an inside diameter of about nine feet. Its walls will be almost nine inches thick and will be made of carbon steel plates and forgings with a ¼-inch stainless-steel cladding. Total estimated weight

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N-A-X ALLOY STEELS in national defense equipment serve a dual purpose. First, they readily meet the rigid standards so necessary in this type of equipment. Second, while performing capably, these alloy steels do contribute greatly to our national economy through conservation of critical alloying elements.

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TYPICAL SPECIFICATIONS*

RATE OF CHANGE ... 0 to 300 G's in 150 milliseconds (max.)

ACCURACY ... 5% duplication of nominal demand curve as determined by programming cam

REPEATABILITY ... 2.5% of actual demand curve

WEIGHT, SIZE LIMITS ... tests two 1 lb. units simultaneously, test units up to 10 pounds, 100 G's, and 125 cubic inches or smaller

CONNECTIONS ... 18 slip rings for input or output

POWER REQUIREMENT ... 110 v, 60 cycles, single phase, 1.5 kva

220 v, 60 cycles, three phase, 6.6 kva

* *Special performance characteristics to order.*

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of the reactor vessel will be about 500,000 pounds.

The enriched uranium fuel will be made in the form of plates clad with a zirconium alloy. The natural uranium will be made into a cohesive mass and placed in zirconium-alloy tubing.

The flow of extremely pure water, which serves both as moderator and coolant, will be 45,000 gallons a minute for 3 main coolant loops. Though 4 loops will be installed, only 3 will be required to produce the 60,000-kilowatt minimum design power. The water will be under 2,000 pounds' pressure per square inch with an average temperature of about 525 degrees Fahrenheit.

The entire nuclear portion of the power plant will be housed in four steel containers which, in turn, are in concrete compartments partially below ground surface. The turbine generator will operate at 1,800 revolutions a minute, and the steam conditions at full load will be 545 p.s.i. without superheat.

DATA DECLASSIFIED

All technical information on currently used extraction processes for recovering uranium from uranium-bearing materials to produce unrefined uranium concentrates has been declassified.

The AEC has determined that the information no longer has security sensitivity and that its declassification would benefit the Commission's raw-materials program by encouraging private enterprise to participate in the program and to develop cheaper and more efficient methods of processing uranium ores.

The declassification action does not include information relating to the refinement of uranium concentrates into highly purified forms, nor does it include technical information on any new and important extraction processes which may be developed.

NEW POWER REACTORS

Projects proposed by the Detroit Edison Company and Associates and by the Nuclear Power Group led by Commonwealth Edison Company of Chicago have been determined by the Atomic Energy Commission to give promise of significantly advancing power-reactor technology and providing an acceptable basis for negotiation under the Power Demonstration Reactor Program. Accordingly, the Commission has authorized negotiations with the two groups.

Detroit Edison and Associates propose construction and operation of a fast breeder reactor plant with 100,000 kilowatts of capacity to be completed in late 1959. The plant is to be located within the Detroit Edison Company's service area.

The Nuclear Power Group's proposal,

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Cline Electric is proud of the part it plays in this country's growing armed might! Whether it's Cline's precision built 20mm guns . . . or voltage regulators . . . or other electrical apparatus for aircraft, you can depend upon Cline's *quality in quantity*. As a prime or subcontractor, Cline Electric produces only the best!

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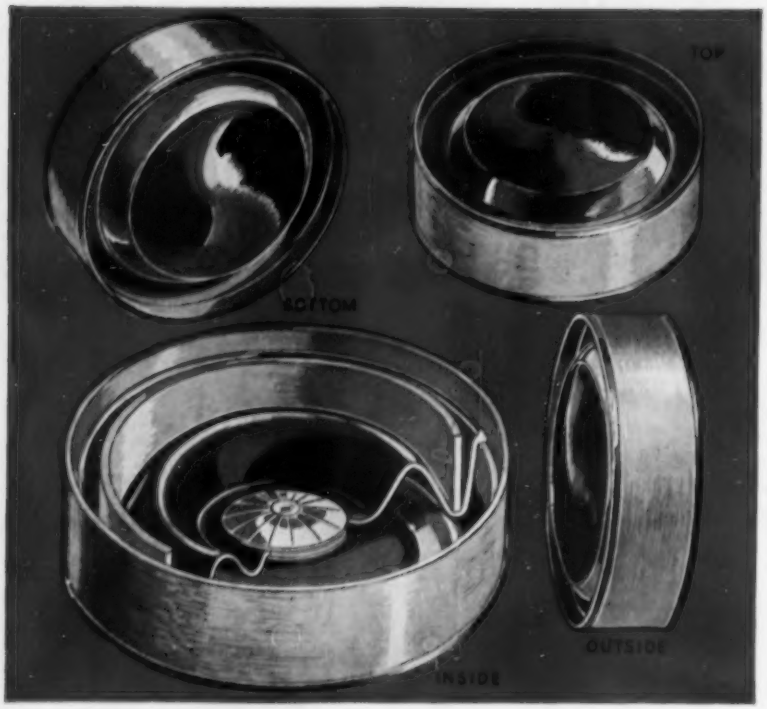

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Atomic Energy

which needs only to satisfy requirements applicable to AEC licenses in order for the project to proceed, is for a boiling-water reactor plant of 180,000 kilowatts' capacity to be completed in 1960. The planned location is at the junction of the Kankakee and Des Plaines Rivers about forty-four miles southwest of Chicago.

The Consumers Public Power District of Nebraska proposes a sodium graphite reactor plant of 75,000 kilowatts' capacity to be completed in 1958. The location is not yet determined.

The Yankee Atomic Electric Power Company is proposing a light-water-moderated and -cooled reactor plant of 100,000 kilowatts' capacity to be completed in 1958. The plant would likely be located in Massachusetts on the bank of the Deerfield River in the township of Rowe, near the Vermont border.

In addition to the four proposals under the Power Demonstration Reactor program, the Commission has under consideration an application by the Consolidated Edison Company of New York for a license to construct and operate a pressurized-water thorium-uranium converter reactor plant of 140,000 kilowatts' capacity and a proposal by the Rural Coöperative Power Association of Elk River, Minn., for a reactor plant of 22,000 kilowatts' capacity.

The Consolidated Edison plant, to be built on the bank of the Hudson River at Indian Point, Buchanan, N. Y., about twenty-four miles north of New York City, is planned for completion in 1960. The Elk River plant, to be located adjacent to the Mississippi River near Minneapolis, is planned for completion about 3½ years after start of construction.

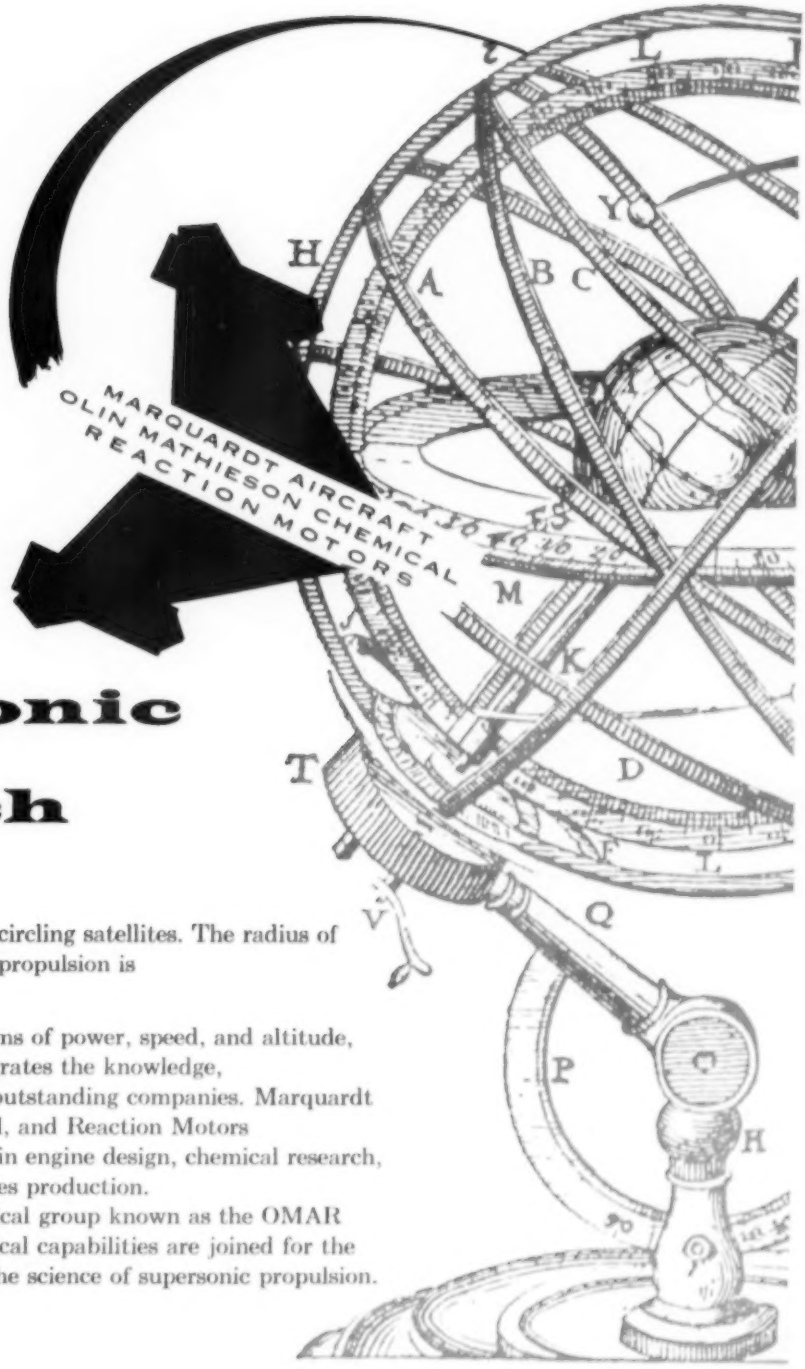
EXPORT CONTROLS RELAXED

The Atomic Energy Commission has formally amended its facilities regulations to provide for the elimination of existing controls applicable to components of production and utilization facilities. The principal effect of this action is to remove AEC export licensing controls with respect to certain electrical, industrial, and scientific instruments and equipment items useful in atomic energy work.

The items involved in this action, as announced by the Department of Commerce, are radiation detection and measurement instruments, mass spectrometers and mass spectrographs, large vacuum diffusion pumps, and certain types of electronuclear machines.

The Commission has been informed that the Bureau of Foreign Commerce, U. S. Department of Commerce, will concurrently institute export licensing controls for most of these items due to their potential strategic applications.

new orbit for supersonic research



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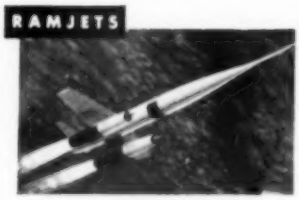

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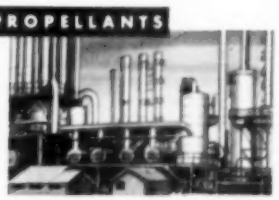

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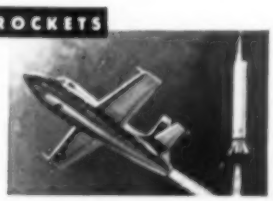

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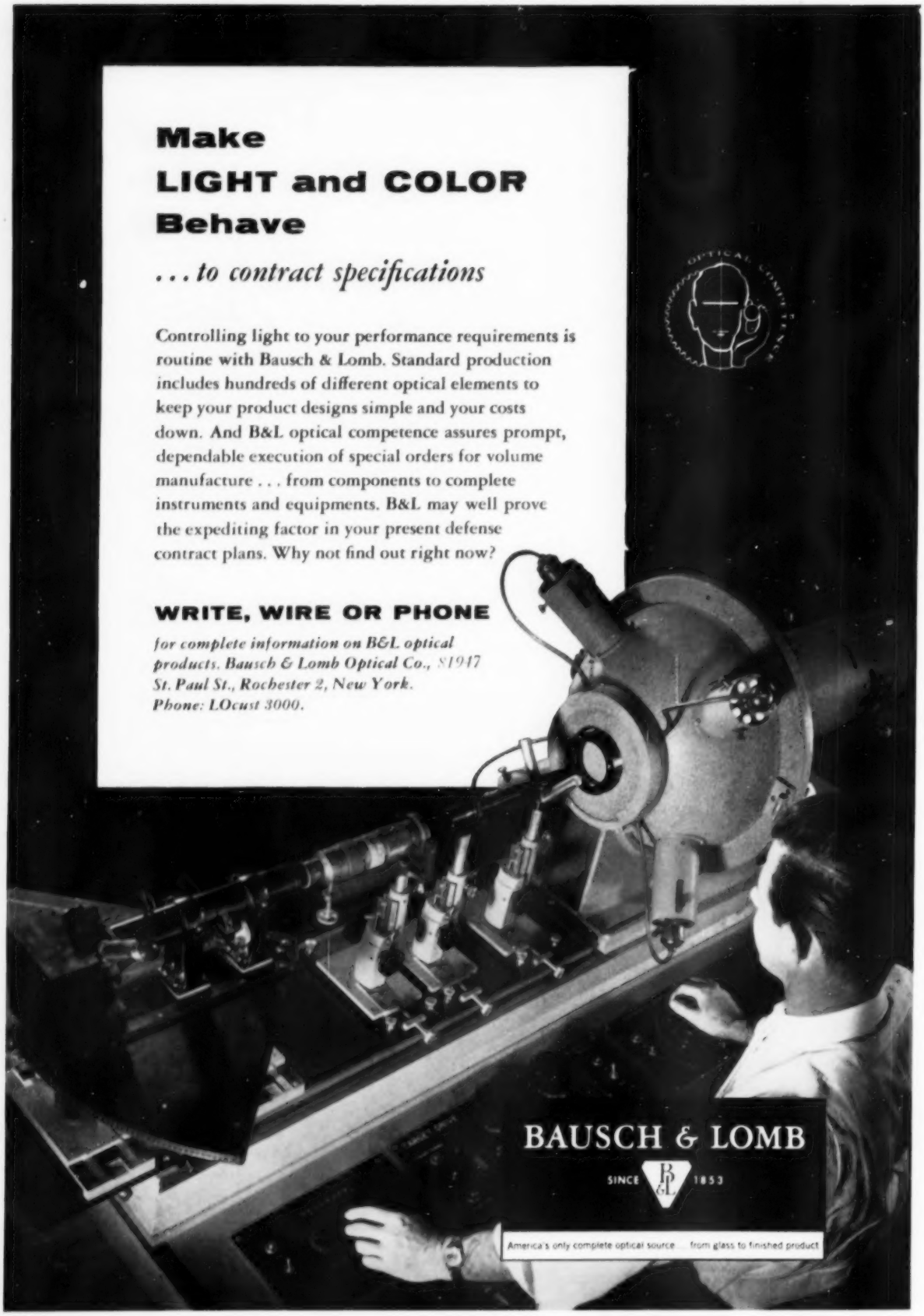

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Commander in Chief
Continental Air Defense Command

Defense in the Air

The Mission of the Continental Air Defense Command

SIMULTANEOUS and widely diversified air attacks can be directed against any or all of the major military and industrial targets within the United States at any time.

Communist nations have both a powerful long-range air force and a stockpile of weapons of mass destruction. Potential enemies have the capability of unleashing an air attack of tremendous proportions against our country.

We do not know whether such an attack will come in our lifetime. If it is contemplated, we do not know the hour. Our only certitude is that if such a deadly attack is ever launched against us, it will attempt to destroy national resistance with one mighty coördinated, far-ranging, and utterly devastating atomic punch.

CAN we adequately defend ourselves against such an annihilating sneak attack?

Should such an attack occur, the President of the United States would immediately assume the offensive and instantly order an air armada directly to the enemy's heartland to destroy enemy air forces at their source—in the enemy homeland.

But the destruction of enemy air power in his own territory does not answer the question of whether we are capable of national air defense here at home against the initial enemy air assault. If major American cities are devastated, it will be small consolation to know, if we survive at all, that severe retaliatory damage has also been inflicted on enemy targets.

The performance of the air-defense mission requires the participation of many agencies:

1. The Air Force provides the basic organization.

2. The Army provides antiaircraft artillery units.

3. The Navy and Marine Corps will operate off shore at sea and in the air.

4. The Air Force Reserve and the Air National Guard are in a state of mobilization readiness for augmentation of the active air establishment in time of national danger.

5. Various civil agencies are coöperating in the air-defense mission.

The Continental Air Defense Command's operations are divided into four distinct phases: detection, identification, interception, and destruction.

For detection, our defense system relies mainly on radar and the voluntary services of the Ground Observer Corps. The construction of a main control and one of three warning radar barriers in this country and Canada has been completed. By 1956 we expect to have one million ground observers in all parts of the country.

For identification, we rely mainly on the strict control of air traffic on our borders and coasts and around critical target areas within the United States.

For interception, we have fast jet all-weather fighter-interceptors specifically designed for the air-defense mission and capable of intercepting a target while flying on instruments.

For destruction, we rely on jet interceptors equipped with new fire-control, aërial rockets, and air-to-air missiles and on Army missile batteries.

To ensure the close integration of triservice air defense, the Commanding General has an Army general officer and a Navy flag officer as his deputies at Air Defense Command Headquarters in Colorado Springs.

THE success of our air-defense system depends on three factors: adequate warning of approaching enemy bombers; superior land, sea, and air ordnance; and top command excellence.

Our warning system, in coöperation with Canada, now extends well up toward the Arctic Circle; our aircraft are alert; our ordnance is superior. The American Ordnance Association will continue its unflagging efforts to maintain this superiority. To General Partridge who is an experienced and dedicated officer, a veteran of three wars, and a most worthy successor to Gen. Benjamin W. Chidlaw, the Ordnance Association offers its full coöperation.

Gen. Earle Everard Partridge, newly appointed Commander in Chief of the Continental Air Defense Command, whose photograph appears on the opposite page, began his military service in World War I, seeing action in the Argonne offensive with the 79th Division.

Graduating from the U. S. Military Academy in 1924, he was commissioned in the Army Air Corps. He held various posts as instructor, test pilot, and organizer of new air facilities.

In 1941 he was assigned to the Air War Plans Division and in the following year was made a member of the War Department General Staff to serve on the Joint Strategic Committee, Joint Chiefs of Staff.

During World War II he served with the 12th Bomber Command, the Fifteenth Air Force, and the Eighth Air Force, assuming command of the latter at the close of hostilities.

Assigned to the Fifth Air Force in Japan in 1948, he took the Fifth to Korea in 1951.

General Partridge was commanding general of the Air Research and Development Command, and in 1953 became Deputy Chief of Staff, Operations, at Air Force headquarters. In 1954 he assumed command of the Far East Air Forces at Tokyo, Japan.

On July 20, 1955, he became Commander in Chief of the Continental Air Defense Command and Commander of the Air Defense Command.

What About Our Tanks?

Lack of sufficient time and money for proper research and development has resulted in a medium tank with a limited radius of operation and other deficiencies that should be remedied in the piping days of peace

Mark S. Watson

THERE is no secret about the fact that, despite the large merits of the Army's present medium tank, the M48, something very much better adapted to battle conditions in the nuclear age is required. The requirement is imposed by two circumstances:

1. The M48 itself was an interim development—the Korean war (and more especially the thought of what it might lead to) made it necessary for the Army to provide a new tank in a great hurry without a long period for study, design, test, and redesign. This meant a "crash" development, with insufficient opportunity for assuring either maximum efficiency or maximum economy.

2. Atomic artillery has come into existence, even to the point where many regard it as "conventional." With it has come a radically changed system of battle tactics calling for frequent and very rapid movement of troop formations in the battle area for dispersal, reassembly, redispersal, and swift pursuit. Distances to be covered are much greater than in the past, which means that armor will be more widely used and that it must be capable of much wider ranging than ever before.

The fact is that under more ideal conditions of weapons research and development than have prevailed since 1945—and still prevail—the very considerable deficiencies of the M48 would have been foreseen and averted. Time itself brings new requirements, and all weapons eventually become obsolescent, but patience and foresight when allowed to function can prevent such errors or misfortunes as are due solely to haste.

Mr. Watson is a well-known military analyst and a member of the staff of the Baltimore Sun. *He is a holder of the 1945 Pulitzer Prize for international correspondence and a regular contributor to* ORDNANCE magazine.

It is the misfortune of the armed services that ill-timed "economies" between wars—the very periods which offer ideal opportunity for painstaking and daring research at moderate cost—have terribly handicapped our scientific research and our technological development. The M48 tank is just one of the countless victims of economy exercised to excess and in the wrong season.

It would not be surprising, then, to find just ahead of us another interim design for the medium tank, so marked is the need for certain betterments which must not be unnecessarily delayed.

The hope is that, looking further ahead, one may discern a still more advanced design, methodically developed this time through study of the new warfare's foreseeable requirements, of the limitations of materials, and of the shifting emphasis among the various priorities—speed, maneuverability, range, firepower, stowage, armor protection, vulnerability, compactness, and viability.

Such a vehicle will not come about as an interim device, nor through any crash development. It will be the fruit of research and development on an orderly, programmed basis, no doubt covering years but thereby avoiding the costly blunders of haste, of which more will be said a little later.

THE most worrying single demerit of the M48, excellent as that powerful weapon is in many respects, has already been hinted. The tank's range of action is limited—unofficially it is declared to have less than half the range of a comparable Russian tank.

Frequently it has been said, and by people who should know better, that this serious deficiency is due solely to the fact that the M48 uses a gasoline engine rather than a Diesel, with an implication that the Army's use of the less-efficient type is due to plain obstinacy.

That is so far from the fact as to call for a brief survey of the record. One may start with mention that, in the opinion of very high authority in the Ordnance Corps, the M48 is the best medium tank in the world today, with fewer defects than any other tank in our history.

"Best" is a strong word. It would be folly to assert that the M48 is "best" in every respect, for there are many qualities which a tank must have, some of which must be deliberately balanced against others, and the weighting as to speed, firepower, vulnerability, etc., respectively, which should be given in estimating the excellence of the whole will vary both with the individual estimator and with the particular mission to be performed.

Granting differences of opinion, the estimate of the Army Ordnance Corps, while understandably partisan, must be regarded with respect.

The M48's immediate predecessor was the M46, an outgrowth of World War II experience. But also we had the M26 (Pershing), a good tank by late World War II standards, and the end of the war disclosed that there were some 1,000 hulls of that type on hand. Also, the end of fighting in 1945 inevitably heralded the beginning of "economy" in extreme form.

WITH scant money in prospect for further development, therefore, it was decided to make use of those hulls to produce a better tank and to employ such funds as were available for further research on all components, from the gun to the tracks.

The component most in need of betterment was thought to be the engine. We had entered World War II with five basic engines for tanks, a variety which imposed a difficult problem in supply and repair. Now, on the contrary, effort managed to produce one basic type of engine for five types of vehicle—a fair-sized miracle in logistics.

Engineering tests were followed by action tests, of a sort—for nothing can be regarded as fully developed until it can be produced economically and in a form satisfactory to the user. Now the new Ordnance engine for the Army's proposed heavy tank was so powerful that it greatly pleased the Armored Force as a component of the new medium tank as well. The reason is apparent. It produced 800 horsepower—twice that of the old Pershing, and there was no doubt that this would provide what was desired in the way of speed and power.

Unfortunately there seems now, in retrospect, to have been less thought of the fact that, in one Ordnanceman's words, "a Cadillac will not travel as far as an Austin." High power must be compensated for in two respects: it means more gas consumption, and it calls for a bigger engine—which means more armor to surround the engine, with the weight of the whole mounting disproportionately.

(In the realm of airplane design there was an instance of adding "only a hundred pounds" in a new device. By the time it was mounted, the fuselage enlarged, the supports strengthened, and a larger engine added to take care of all that, the added weight was one thousand pounds.)

Nor was the disproportionate increase in the tank's weight the only unhappy consequence. The improved tank began to lose out in radius of action (because it burned more gas) and to cause logistical worries because of the need to haul more fuel to the forward area. The greater bulk also made a larger target with a consequent increase in vulnerability.

There was an impressive argument for developing a comparable engine on the Diesel principle, which would make fuller use of available BTU's and hence avoid to some extent the increase in space and weight requirements, but this was vigorously opposed at the time on a number of counts.

We all are familiar with the fact that for trucks and tanks alike Europeans make much more use of Diesels than we do, largely because of dollar economy—all petroleum products being more expensive than in America (which explains the wide use of small-sized, high-compression motors in their passenger vehicles, too).

It is fair to point out that the European motor manufacturers, naturally concerned with that large home commercial market, have undoubtedly concentrated with great skill on Dieselization to a greater degree than we have.

BUT beyond all this, upon which a great deal may be said pro and contra, there was an important supply consideration which was pointed out as a serious argument against Dieselization; namely, that the arrival of a war emergency would have a pronounced effect on the basic petroleum-products market, especially in the civilian area.

Part of our present tank family are, left to right, the T43 heavy, M48 and M47 Patton mediums, and M41 Walker Bulldog light. *Army photo*

The Navy's surface and subsurface vessels, all jet aircraft, many railroads, and many indispensable truck and bus lines would all increase their consumption of low-grade petroleum fuels, creating a grave problem of fuel supply for the Army's own tanks and self-propelled guns and trucks generally, if they, too, should be Dieselized.

On the contrary, war would inevitably bring restrictions on the use of all pleasure automobiles (using higher-test gasolines) and thereby create a relative surplus of gasoline. This, it was argued, would actually reduce the Army's problems if its engines should be gasoline burners rather than Diesels.

THIS argument was a potent factor in the ultimate decision, despite European practice and the known fuel-economy of the Diesel. The new tank family was to have gasoline engines, with full knowledge that this would raise a problem about the tanks' range of action.

The problem, therefore, became one of improving the gasoline engine so as to obtain from it more miles to the gallon. It would be wrong to think that research in Diesels is canceled. It is not. There are research people who contend in a highly persuasive manner which may win support, that the Diesel's essential virtues are great enough, in a battle vehicle requiring long range, to justify much more study. Their quest is fuel economy attained by a powerful but exceptionally compact engine small enough to escape that previously mentioned spatial accompaniment of powerful engines—bulk which must be surrounded by an excessive amount of armor.

But there are interesting conjectures leading to explorations of what might be done with a non-Diesel engine possessing compression-ignition characteristics (and hence fuel economies) without the restrictions of the Diesel as to type of fuel.

Probably any student of motors, faced with the problems so manifestly present in tank development, would search for answers in several fields. For instance: (1) How to get more power out of the fuel in use. (2) How to meet the stated mission with less power. (3) How to find a smaller-sized plant. (4) With all this in mind, to take a new and searching look at the tank's fundamental characteristics (firepower, mobility, and protection) to see whether, under new conditions of warfare, there has been a change in their several weightings.

One is tempted to ask why this was not all worked out in the design of the M48. The answer is easy. The Korean action came too quickly, and its implied threat was too great to allow for that careful research which under happier conditions as to "economy" would have been taking place in the peaceful years immediately preceding.

Ordnance research, which already had been under way on a painfully restricted basis, had to be halted where it was. The "dream tank" contemplated had evolved a few excellent potential components, but instead of continuing development it was necessary to jump into production of the M47 right away.

The result was patchwork, with so many defects that with undue haste the M48 was started, again on a crash basis, and again lacking thorough, deliberate pursuit of certain fundamental concepts which were still half developed.

This is as good a time as any, because the painful lesson is squarely before us, to point out some fundamental facts of research itself. The first is that if in each of the four years before Korea the automotive-tank research group of Ordnance had been granted as much as $15,000,000 (instead of the $4,000,000 or so which was left over after other research projects had been financed) we would have had a far better tank and at a large saving.

Money is important in research. And, painful as it is to correct a popular belief, it is not needed exclusively to buy brains which, it happens, often come with a rather small price tag. Research and development need large funds, rather, for plain "hardware." In the case of armored vehicles, as much as $1,000,000 may go for a single tank model—and two or three models may be needed before the testing has matured and the maker can shift to production models.

THE initial preproduction outlay on a tank family (including the trucks, recovery vehicles, tank transporters, and self-propelled guns, using in common a maximum of identical parts) could cost the automotive-tank group, say, $8,000,000—quite a bite out of small research and development funds.

The T43E heavy tank is armed with a 120-mm. gun and caliber .30 and .50 machine guns.

But, as noted, that group did not get the $15,000,000. Only about $48,000,000 was being given to Ordnance for all research and development needs, and this had to be portioned out among a variety of projects. Guided missiles, not unnaturally, had a first priority, and the emergence of the Nike in particular tends to justify it.

Recoilless rifles of several types were not far behind in urgency, and a number of other very flashy possibilities clearly had to be explored. Economy programs when they reached the extreme point to which America always has been addicted between wars can be very expensive in the end, for what is consequently delayed until wartime becomes far more costly in money and effort as well as in time.

Economy tends to discourage altogether anything that looks expensive—so that the Westervelt Board's tank proposals between the two World Wars were completely shelved while money was spent on two new mortars and the Garand rifle, not solely because they were good, which they were, but also because they were relatively cheap.

IT does not always work that way, however, and sometimes (as in the case of tanks after World War II) money is denied research even upon a conventional item, if the existing type is fairly good, and is liberally spent on a more glamorous new project.

Excessive economy discourages all research by limiting total funds and causing a horizontal decrease in outlay. It also discourages particular research projects because after a time the economizing cannot be continued on a complete horizontal basis but must become selective and eliminate such projects as seem postponable in the interest of the unmistakably urgent.

Excessive economy likewise discourages any expensive leaps into the unknown, and that is unfortunate because the most important things of a decade hence may be unknown at the moment. Altogether, excessive economy is hard on bold new enterprises and also on nonglamorous projects. Its most deplorable aspect may well be that it apparently is inescapable in the armed services' feast-or-famine allowances.

The M48 medium tank may have too limited a range for nuclear warfare.

For this, too often, Congress is reproached, and that is not fair. There are few cases in which Congress has denied funds for research, once the need for those funds has been clearly demonstrated. The denial, rather, has been in the Executive Branch's recommendations to Congress.

But let us return to the specific case of the medium tank and its clear need for "longer legs," quite apart from certain other desirables not under review in this article. The case for Dieselization is not closed, but it is not at all the sole field of exploration or even the likeliest one. We can think of a threefold attack upon the problem of getting more range of action for our armored task forces:

1. The scientific approach, concerned with fundamentals of design and new materials which will prove stronger and lighter.

2. The engineering approach, which seeks improvements in mechanical performance and notably in space saving which reduces the interior and, necessarily, the outer shell also, and hence the weight of armor.

3. The functional approach which seeks to strike an optimum balance of military capabilities. How good are speed and agility, as computed against full protection and the penalty paid for it? All the capabilities requested perhaps could be built into a tank weighing 100 tons, but would we want it?

All three of these approaches are under constant exploration, but the first has obvious limitations, and the third is something which is basically determined by the using services. That means that Ordnance in its immediate program, as distinguished from long-term cooperation with the using forces, can work most fruitfully on the engineering approach.

There is a natural reluctance to discuss the exact fields of engineering study beyond the areas in which the motor industries' own research laboratories are known to be at work, sometimes for their own immediate purposes, sometimes under Ordnance encouragement. A vast amount of engineering which now is evident in everyday commercial trucks and in passenger vehicles as well, sprang originally from a demand pioneered by the armed services.

It is apparent, on that basis, that the fuel-injection system (whereby the exact amount of gas needed for each stroke is fed into the combustion chamber without going through the conventional manifold) can be a contributor to the economizing of fuel.

It is equally clear to any automotive engineer, in or out of the armed forces, that any saving whatever that can be effected in the transmission can be immensely productive, for something like forty per cent of the thermal units' full energy vanishes between the flywheel and the rear axle of a typical passenger car.

Nor does it take an expert in military intelligence to know that the cooling system has a weight factor, and that the more weight there is in the tank, the more cooling is required.

It is a fair guess, then, that these are

included in the many engineering areas under research by the Ordnance engineers. It also is a fair guess that the using services themselves are engaged in some second thoughts, now that they are face to face with a tank (built to satisfy the requirements laid down by those services) which they now see ought to be lighter, and hence capable of going farther, and which could use more firepower for one purpose and less for another.

It is not unreasonable to think that there could be some profitable reconsideration of what is the essential rôle of a given variety of tank. Is it for support of the Infantry in a slugging contest? Or is it for far-ranging and highly profitable exploitation of opportunity (old Cavalry fashion) on the enemy flanks or in his rear areas, where he is weak rather than strong?

GRANTED that both needs are compelling, is the same tank to be used for the two purposes? This is no new debate. It started at the beginning when the Army, torn between Cavalry and Infantry desires to get control of this new weapon, decided to grant both desires and allowed two different lines of development, which to this day are merged in Armored personnel's thinking. Maybe they will continue so, and should.

On the other hand, maybe time, plus atomic-warfare considerations, will bring to pass an altered concept, involving greater use of self-propelled guns in this respect and lesser need for a 360-degree traversing turret with its added space-and-weight requirements, and other revisions of function or performance which will ease the admittedly serious problems which engineering designers find in the existing tank specifications.

ONE cannot fully understand the space-and-weight problems raised by the revolving turret unless he is familiar with the related problem of the gun, whose breech is in that turret. The using forces wish as powerful a gun as they can get, and that is understandable, for the tank's prime mission is to carry just that kind of gun. But in the quest for size, range, and precision, up to now they have utilized a large rifled gun.

Now it is fundamental that when the piece is fired, its rifling (which provides precision) necessarily traps a great deal of the propellent-charge's expanding gas. This means that the breech must be extremely sturdy to withstand the pressure, and that means it must be large. The turret also must be large enough to permit space for the gun's long recoil.

But excessive interior space calls for excessive external armor, which brings us back to the eternal space-and-weight problem and a suspicion that redesign of the gun is worth thinking about. Away back in World War II the British tankers were thinking of a smoothbore gun (the projectile's flanges providing precision) as a replacement of the rifle for this very reason.

Some of the M48's large fuel requirements are inherent in tank operation as well as in orthodox tank design. Operation calls for long periods of idling motors while the tank force is being put in readiness for a change of order. Passenger-car users are familiar with the fuel cost of idling, for the same car which will get 18 miles to the gallon on the road will get but 12 or so in the busy city. (The Diesel, it happens, uses little fuel while idling.)

Driving methods have something to do with fuel economy, and continuous instruction and supervision of drivers will help—much as Charles Lindbergh's wartime instruction of air pilots in the Pacific produced great improvements in the pilot's ability to perform more distant missions for much longer periods of time.

The claims for Russian tanks' greater superiority, it must be added, call for examination. It will be remembered that the Russian tank is an extremely austere mechanism. It does not have the auxiliary equipment which is carefully built into ours. Its telecommunications are markedly inferior and its fire control primitive.

Its functions, therefore, are fewer. Hence the compartment can be smaller, and the crew members are jammed into spaces so small that one must suspect that their combat efficiency is lessened.

IT is a question whether the Russian tracks will stand up for a long time; if they do not, then the Russian engine's great range potential will do the tank little good. The "luxuries" of our tanks upon analysis do not seem to be exactly luxuries but, rather, contributing factors to high morale and combat effectiveness.

Emergencies of the past have necessitated crash production, and no doubt will do so again. Fortunately we are not in a true emergency at this moment, and there may be time for fuller consideration, which means fuller research. There might also be the funds for it, although that is not the fact now.

But Korea's lessons ought still to be apparent—that production in 1950-1953 was unnecessarily costly and the weapons not as good as would have been possible under a more leisurely rearming program. We had to turn out the M47 instead of a tank designed in an orderly manner.

We had to rush into production of the M27 recoilless rifle when, with a little more time and money spent after 1945, we could have had, instead, the "BAT" (battalion antitank weapon) with three times the M27's penetrating power and four times the probability of a hit, at two-thirds the M27's weight and a smaller unit cost. We could have had a whole new series of self-propelled guns better than any we now have.

AS Maj. Gen. Leslie E. Simon, chief of Ordnance Research and Development, remarked to Congress in reply to questioning, the Army cannot rush to correct flagrant existing deficiencies without sacrificing the chance to develop really superior weapons, nor go to premature production without freezing certain defects of hasty design.

It would be a sad thing to have the country deplore the costs of the post-1945 "economies" in research, without looking searchingly into the question of whether the 1955 economies in that field are wisely ordered. The inquiry could start with the tank program and keep right on.

The Thermal Barrier

Intense heating of aircraft and missiles as they pass through the earth's atmosphere at supersonic speed imposes problems of design and materials that may prove very difficult of speedy solution

Dr. George Gerard

A SIGHT familiar to every one is the brief blaze of a shooting star across the sky on a summer night. The earth's atmosphere, acting as a protective shield, aërodynamically heats the entering meteorite to incandescence. This same phenomenon now looms as a serious deterrent to man's quest for unlimited speeds for his aircraft.

Although medium-size meteors are evaporated by aërodynamic heating, very large and very small (0.04-inch radius) meteorites do reach the earth's surface. It is interesting to note that the mechanisms by which such meteorites can successfully endure aërodynamic heating without total destruction may hold important clues to possible solution of the reëntry phase of missiles and eventually space ships—a critical thermal problem.

Small meteorites, by virtue of their relatively small mass, decelerate very rapidly upon entering the earth's atmosphere and thereby effectively limit the amount of aërodynamic heating experienced. This mechanism of large drag-to-weight ratio may have a bearing on the design of space ships.

LARGE meteorites reach the earth through melting of some of their outer surface. Although tremendous heating occurs, the time involved is relatively short. Thus, the surface melts while the interior remains relatively cool. This mechanism of sacrificing part of the structure by melting is of interest to designers of long-range missiles.

In this regard it is instructive to consider in some detail the make-up of the earth's atmosphere. Some of the known facts and nomenclature commonly used by the aëronautical scientist are depicted in Figure 1, where the vertical scale indicates altitude.

On the left of Figure 1, the ratio of the density of air at altitude to sea level is shown. Below 100,000 feet lies approximately 98 per cent of the mass of the atmosphere, while only 2 per cent is above. This remaining 2 per cent extends from 100,000 feet to approximately 600,000 feet. This region is known as the aëropause—it is the frontier before the emptiness of space.

Within the first 100,000 feet, air-breathing engines—piston, turbojet, and ramjet—can provide sufficient propulsive thrust. Propulsion specialists generally concede that 100,000 feet is the upper limit for air-breathing units. When it is considered that less than two per cent of the atmospheric mass lies above this altitude, then one realizes how close to the limit air-breathing propulsive units may be developed.

In the aëropause and beyond, all the products to be exhausted as the propulsive mass flow must be carried aboard the aircraft. Thus rockets or possibly some other form of nonair-breathing propulsive units are to be used in the aëropause.

Another feature of the atmosphere of vital concern to the aëronautical engineer is the altitude-temperature variation shown toward the right in Figure 1. Under standard conditions, the temperature is 60 degrees Fahrenheit at sea level and drops to minus 67 degrees Fahrenheit at 35,000 feet—the altitude level between the troposphere and the stratosphere. The temperature remains constant at minus 67 up to approximately 125,000 feet and then varies as shown in Figure 1.

THE temperature variations up to approximately 100,000 feet are well established and the fluctuations well known. The variations in the aërosphere are comparatively new and are based on data gathered from rocket flights. There are indications that extreme day-to-night fluctuations occur.

From the standpoint of the aëronautical scientist, the atmosphere can be considered as a continuous gaseous medium (continuum) up to approximately 200,000 feet.

Beyond this level, the average spacing between air molecules (mean free

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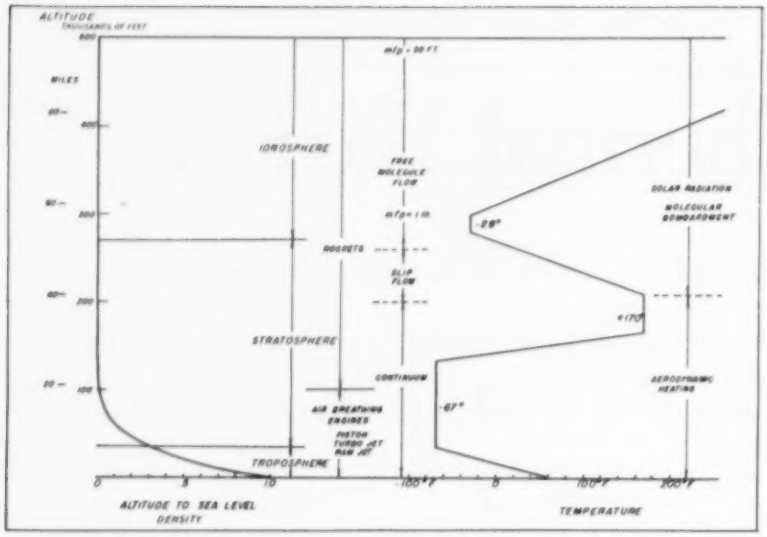


Fig. 1. Simplified drawing of the composition of the atmosphere.

path) becomes so large, relatively, that the atmosphere can no longer be considered as a continuum. Instead, the motion of individual molecules of air must be considered in computations.

Therefore, up to 200,000 feet, aërodynamic heating is of importance due to the continuous nature of the atmospheric medium and the fact that almost 100 per cent of the atmospheric mass is in this region. Beyond this altitude, heating of the aircraft is caused by solar radiation and bombardment of the aircraft by gaseous molecules. In space, solar radiation will be the heating source.

ALTHOUGH we have just considered certain characteristics of the atmosphere between sea level and outer space, the remainder of this article is concerned primarily with the region between 35,000 and 100,000 feet. This is the region of lowest atmospheric temperature, it is the region of airbreathing engines, and it is the region of severe aërodynamic heating. Aircraft developments in the next decade will be very much concerned with this region.

Now let us consider the manner in which aërodynamic heating is generated and the temperatures and amounts of heat which confront the aircraft designer.

A moving aircraft is surrounded by a relatively thin layer of air in which frictional effects predominate as the still air is accelerated to the velocity of the aircraft. In subsonic flight, the frictional effects in this boundary layer cause heating which is rapidly dissipated. In supersonic flight, however, the frictional effects plus the heat of compression due to shock waves cause significant heating.

Beyond Mach 2, aërodynamic heating becomes sufficient to affect the overall design of aircraft. Therefore, Mach 2 generally denotes the lower limit of the thermal barrier. As compared with the sonic barrier which occurs in a sharply delineated region at Mach 1, the thermal barrier presents the insidious aspect of encompassing a broad region of increasingly severe thermal conditions as speeds increase.

The two aspects of aërodynamic heating which appear startling are the high temperatures and large quantities of heat generated. In Figure 3 are shown the stabilized temperatures to be expected on the skin of an aircraft after flight in the stratosphere for a sufficient period of time. Upon entry into the thermal barrier at Mach 2, temperatures slightly higher than 200 degrees Fahrenheit are experienced. At Mach 3, the temperature is up to 600 degrees Fahrenheit. At Mach 5, the temperatures encountered are sufficient to melt the best aluminum alloys.

Further, an aircraft flying at such Mach numbers would generate a quantity of heat per unit area of the order of magnitude encountered in modern steam-generating power plant units.

High temperatures are not entirely a new problem to the aircraft industry. The principles of jet propulsion were known for over a hundred years. The eventual development of the first successful turbojet during World War II awaited materials capable of operating under conditions of extremely elevated temperatures.

IN the aircraft, elevated temperatures have long affected the design of the structure near engines and thermal deicing equipment. Beyond Mach 2, however, elevated temperatures caused by aërodynamic heating became a design problem affecting the structure, propulsion units, pilot, and equipment.

For the propulsion specialist, aërodynamic heating of the aircraft introduces new problems in the design and construction of the air induction system and vaporization of the fuel. Once these ingredients are introduced into the greedy propulsion unit, the engine designer faces an old problem with new extremes for turbine and tailpipe temperatures.

A new problem for equipment designers in the face of aërodynamic heating is the loss of a cool air supply. Any air entering the airplane beyond Mach 2 is hot and useless as a cooling medium without a means of removing its heat. This loss of an external heat "sink" has turned the equipment designer to the fuel supply.

However, the fuel system apparently has sufficient problems without any one adding heat to the fuel. Thus, artificial heat sinks must be created. Even the remarkably efficient ones which have recently been developed mean added weight.

Aircraft designers have long bemoaned the deficiencies of modern man. In supersonic flight he needs an oxygen supply, pressurization, escape mechanisms, and a vast display of instrumentation. To this we now must add a fairly large capacity and unfailingly reliable cooling system.

However, as has been said in answer to these criticisms, where else can one

find a nonlinear computer that weighs only 175 pounds and can be mass-produced with unskilled labor?

The sonic barrier of a decade ago was primarily an aërodynamicist's and propulsion engineer's problem. Beyond Mach 2, the structures designer now faces a host of new problems—thermal stresses, creep, decreasing physical properties of materials, thermal buckling, and elevated temperature corrosion problems.

From the over-all design standpoint, all the foregoing problems will be solved—but possibly at large weight penalties. Before adding the complications of elevated temperatures, it is instructive to consider weight trends of aircraft since the advent of all-metal construction in the early 'thirties.

The history of true airspeed and gross weight trends for production fighter and bomber aircraft are shown in Figure 4. The substantial increases in gross weight associated with increases in speed are due to higher performance requirements in range and payload, increasing complexity of equipment, and higher aërodynamic loads.

The addition of weight to the aircraft in the form of equipment, for example, is reflected in increased requirements for the propulsion system, decreased aërodynamic efficiency, and increased structural weight. This compounding of the aërodynamic, structural, and propulsion changes necessitated by an increase in weight is referred to as the aircraft growth factor.

It has been found, for example, that if a weight increment of 10 per cent is added to an aircraft in the preliminary design stages, the additional aërodynamic, structural, and propulsion requirements increase the gross weight by 100 per cent if the original strength and performance characteristics are to be maintained.

THE trend of increased weight with increased speed, such as shown in Figure 4, is partly due to increased propulsion requirements and increased structural weight resulting from the demands of increased performance.

The weight increases also reflect substantial increases in complexity of military equipment. While some control can be exercised over the latter, the trend of weight increases with greater velocities will continue due to aërodynamic, structural, and propulsion requirements.

With the design of aircraft for Mach numbers greater than 2, substantial increases in structural weight are to be anticipated due to elevated-temperature effects. In addition to the natural trend of increased loads with increased velocities, the allowable strengths of the structural materials decrease at elevated temperatures, and creep becomes a design consideration resulting in increased weight for given loading conditions.

Also shown in the lower part of Figure 4 are the weight-strength ratios of the various aluminum alloys used in aircraft between 1930 and today. Projected on this figure in the thermal-barrier region are the most efficient short-time weight-tensile strength properties of the materials which will probably be used in aircraft designed for thermal flight.

It can be observed that even with the continued improvements in physical properties of aluminum alloys since 1930, the gross weights of fighter and bomber aircraft have increased radically. With a reversal in the weight-strength trend of materials at elevated temperatures, the designer of aircraft structures possibly faces a truer barrier than the aërodynamicist did in the sonic barrier.

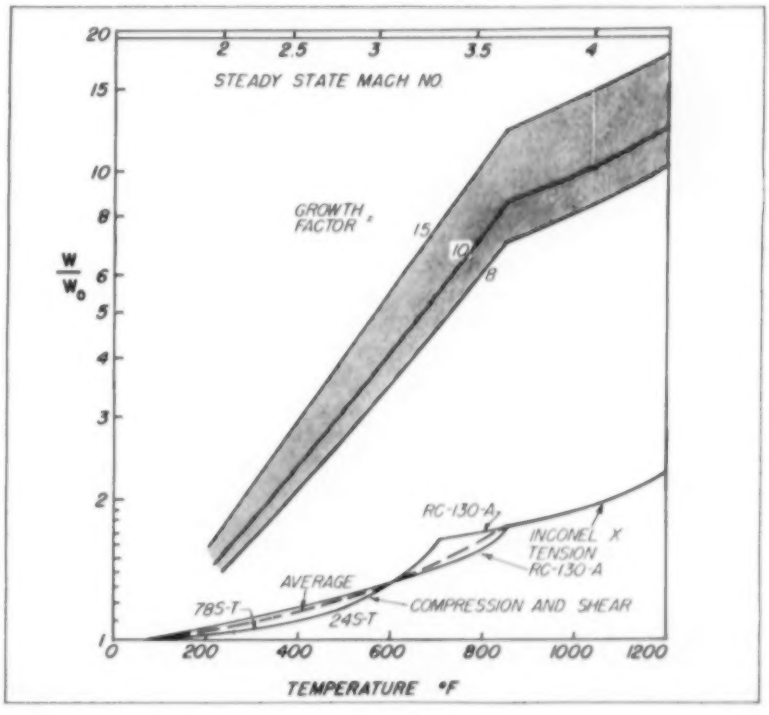
To illustrate the weight penalties which may be associated with thermal flight, an analysis has been conducted of hypothetical aircraft. It is assumed that the aircraft is designed for sustained thermal flight with no provision for cooling of the structure.

It is to be noted that, for sustained flight, insulation can only delay the attainment of the stabilized temperatures indicated in Figure 3. In this analysis, creep effects were neglected.

SINCE the natural growth trends of future aircraft are difficult to establish with any degree of accuracy, an approach is attempted in which the weight increases due to elevated temperatures are isolated from the natural growth trends.

This can be accomplished by considering the relative weights of two air-

Fig. 2. Relative weight trends of craft designed for sustained thermal flight.



craft designed to the same performance specifications. The reference airplane is designed for room-temperature conditions whereas the other is designed for elevated-temperature conditions on the basis of short-time elevated temperature-strength data.

In the lower part of Figure 2, the best materials from a weight-strength standpoint for various temperatures are shown. Separate curves have been drawn for structural components under tension loads and also under compression and shear loads since the latter are subject to buckling.

THE ratio W/W_o represents the weight of a given material at elevated temperatures (W) to that at room temperatures (W_o) for the same strength. It can be observed that at 1,100 degrees Fahrenheit the weight has doubled due to the decrease in short-time physical properties of the materials alone.

The increment in weight above room temperature must be multiplied by a suitable growth factor as discussed previously. This factor accounts for the increased propulsive and aërodynamic requirements necessary to achieve comparable performance of the room- and elevated-temperature aircraft. Therefore, the average relative weight of tension, compression, and shear components was multiplied by representative growth factors of 8, 10, and 15 as shown in Figure 2.

Although the blanket use of a growth factor in this manner may be questioned, the purpose of this analysis was to establish trends rather than absolute values, and therefore it appears permissable to use the growth factor for this purpose.

In connection with Figure 2, it is of importance to note that the average trend of relative weight as a function of temperature was obtained by roughly averaging the trends for the most efficient materials in tension, compression, and shear.

FOR example, at 500 degrees Fahrenheit, this would lead to the use of titanium alloy RC-130-A as the tension material and aluminum alloy 24S-T4 as the compression and shear material.

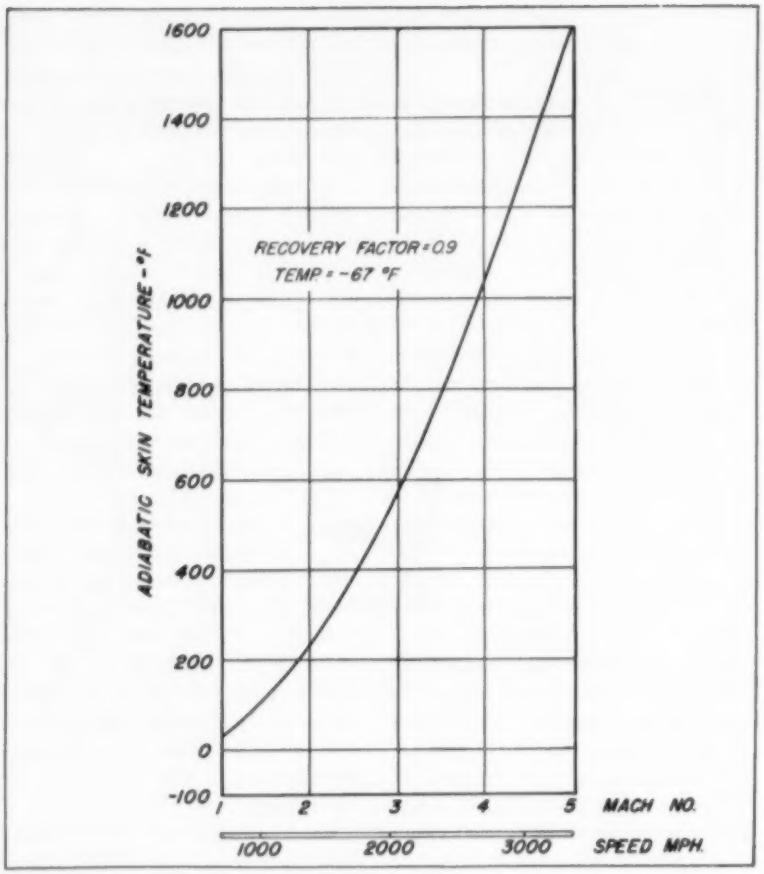


Fig. 3. Steady state temperatures for flight in the stratosphere.

If the same material were selected for the tension, compression, and shear material, then the relative weights for a given temperature would be greater than indicated by the average trend.

It can be observed from Figure 2 that tremendous weight penalties are apparently involved in the design of aircraft for elevated temperatures in terms of what is now required for the usual temperature conditions associated with the operation of transsonic aircraft. It is to be noted that the trends indicated in Figure 2 do not include the trend of increased weight with increased speed such as indicated by statistical data in Figure 4. Thus, weight trends may indicate even larger penalties for aircraft designed for thermal flight than indicated in Figure 2.

Up to this point the analysis has been based on short-time properties of materials. However, a new and significant aspect of thermal flight is that the design of a structure which operates at elevated temperatures entails analysis of the time-dependent creep deformations which occur under applied load.

Depending upon the service application of the aircraft, various criteria, such as stress rupture, creep buckling, initiation of third-stage creep, and specified deformations may be used to indicate the time of retirement of major components of the aircraft structure.

The prediction of life expectancy of an aircraft flying under elevated-temperature conditions entails an intimate knowledge of the applied stress and temperature distributions as well as a complete understanding of the behavior of materials under the complex loading conditions associated with the aircraft operation. From a physicist's and metallurgist's point of view, the phenomenon of creep even under simple loading is rather incompletely understood.

The life expectancy of aircraft under thermal flight conditions will be governed by creep considerations. To de-

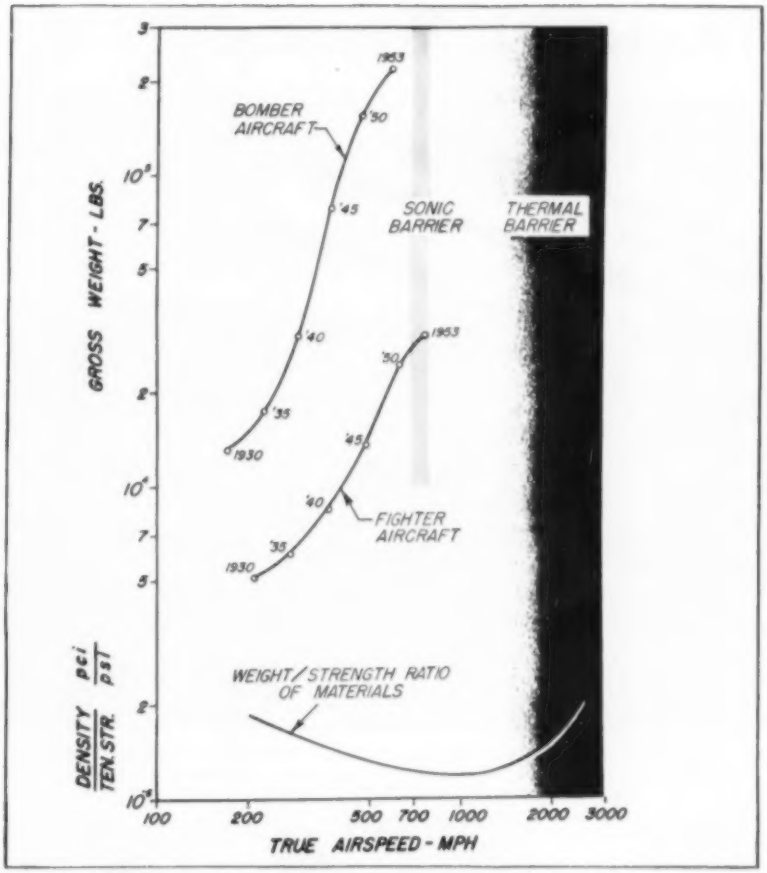


Fig. 4. Aircraft-growth trends and weight-strength ratio variations of materials.

sign the airframe for an unlimited life, even if possible, will result in additional weight to the already tremendous weight penalties associated with static loading. Therefore, limited life expectancy of aircraft designed for thermal flight may be expected as one solution to this problem.

On the basis of trends established by this relative weight analysis, it appears that sustained flight in the region where aërodynamic heating is of importance may be seriously limited by the tremendous weight problem.

ALTHOUGH the upper limit for utilization of current engineering materials is in the neighborhood of 1,800 degrees Fahrenheit, the weight penalty due to decreased material properties resulting from aërodynamic heating may limit sustained flight to the region below 800 degrees Fahrenheit, which corresponds to a Mach number of approximately 3.5.

In spite of this rather dim view of the probability of thermal flight for unlimited periods of time, there are several distinct possibilities under consideration which offer means of "skirting" the thermal barrier. These include prescribed flight paths for thermal flight and methods of cooling the airframe.

To some extent, aircraft under current design will be limited in the amount of time spent in thermal flight by the enormous quantities of fuel used. Because of limited flight times, the structure cannot heat up to the temperatures indicated in Figure 3. The aërodynamic heating encountered will result predominately in thermal stresses to the aircraft.

In the foreseeable future, the fuel problem may be solved by the use of nuclear power plants. In such cases it may be possible to achieve the steady-state temperatures indicated in Figure 2 with the attendant weight problems discussed herein.

A recent American Society of Mechanical Engineers symposium on thermal-barrier problems was marked by widely divergent views on the ultimate effects of the thermal barrier on aircraft development.

This appears to be a natural consequence of the fact that each specialist tends to be concerned with thermal effects in his problem area—propulsion systems, cooling systems, or structures. This symposium emphasized the urgent need for a concerted research effort in this new field.

AS an example of the diversity of opinion currently held, the following approaches to the thermal problem were suggested by different specialists at this symposium:

1. Use various types of systems to keep the aircraft cool. This may require that excessively large quantities of cooling fluid be carried.

2. Fly beyond Mach 2 only for short periods of time to prevent the aircraft from heating up to the steady-state temperature.

3. Use insulation to delay heating effects. However, no insulation is now known which can be exposed to the air stream at such Mach numbers.

4. For sustained flight, design the structure to carry loads at elevated temperatures. A serious weight penalty will be imposed due to lower strength and creep of materials.

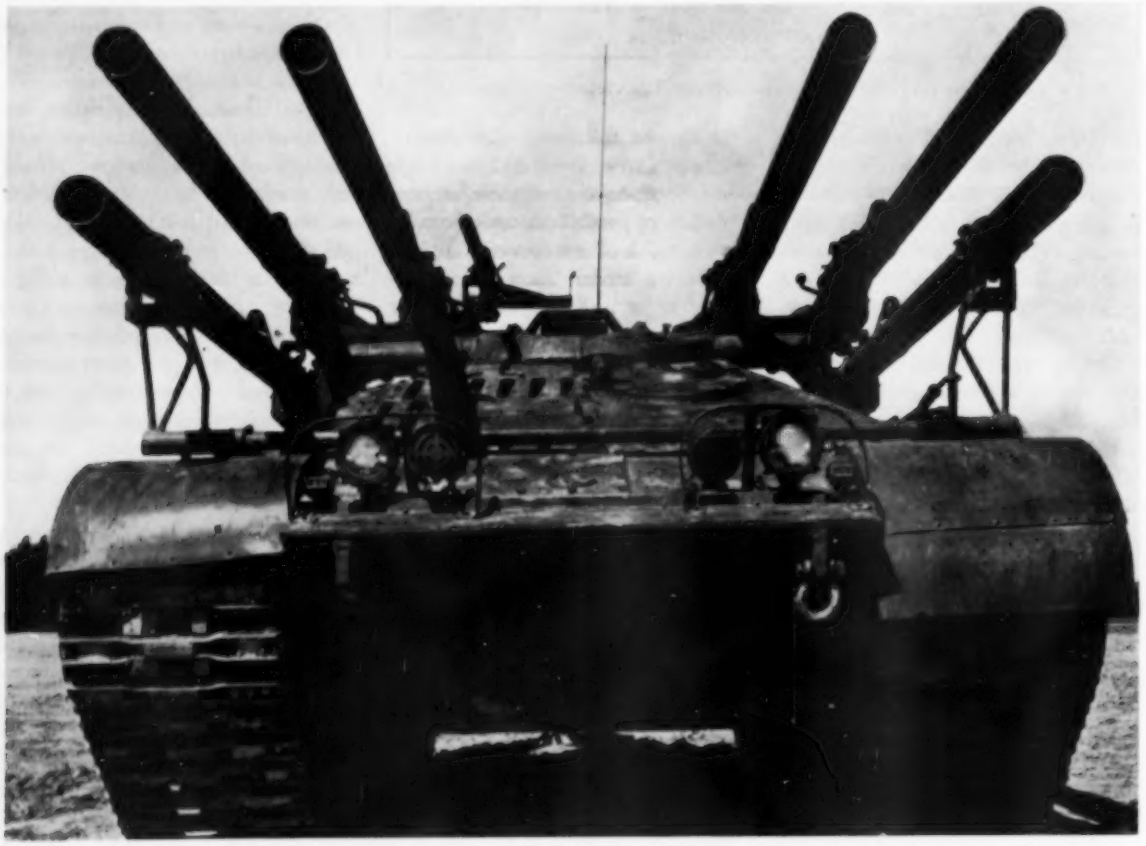
Undoubtedly each of these approaches has value in specialized areas of flight. Therefore, a coördinated research effort is required to delineate such areas. Furthermore, it may suggest possible combinations such as cooling from a high to a lower elevated temperature and then subsequent design of the structure at the lower elevated temperature.

Implicit in all these approaches is the realization that thermal flight places a serious limitation on the life expectancy of aircraft. The new design philosophy which will evolve must account for creep of metals at elevated temperatures.

It may no longer be possible to design a structure for decades of useful life—hours may be a more realistic measure of endurance.

A New Antitank Weapon

Recently adopted as a regimental antitank vehicle by the Marine Corps, this 8½-ton weapon is armed with six 106-mm. recoilless rifles and a caliber .30 machine gun. It also carries four caliber .50 spotting rifles. Known as "Ontos," the vehicle is designed for direct sea to land invasions. It has a top speed of 40 m.p.h. and can climb a 60 per cent slope (Defense photo).



Dangers of the Long Pull

Regular annual expenditures for defense are safer and more economical than our previous policy of feast or famine, providing our allies will remain ready, willing, and able to guard the perimeter through the years

Maj. George Fielding Eliot

WE are told we are now settling down for the long pull in national defense.

In essence, that seems to mean the maintenance over an indefinite period, year after year, of military capabilities sufficient to deter the Communist powers from resorting to war, or, if they go to war anyway, to absorb the first shock of attack, prevent them from gaining a victory by surprise, and provide an expandable base upon which our own power potential can be developed for a full-scale effort to bring about a victory of our own.

The hope is that the deterrent will be sufficient to prevent a war fought with modern nuclear weapons, which would be an unparalleled disaster for all concerned. But no deterrent can be considered as sufficient unless the level of strength is sufficient to win a war if the enemy begins one. The two things go together.

ALL of which is exactly what our first President recommended—in vain—when he asked for a "respectably defensive posture"such as should "appear respectable in the eyes of our friends and formidable to those who would otherwise become our enemies."

It has taken us all the years from Washington to Eisenhower to get around to accepting the fact that steady expenditures for defense, year by year, are not only cheaper in the end than the stop-and-go, feast-or-famine practices which have featured our military policy during all our previous history but that they provide a far more effective level of national security.

Major Eliot is military analyst for the Mutual Broadcasting System and military and naval correspondent with General Features Syndicate. He is also a well-known author and a frequent contributor to ORDNANCE *magazine.*

There is, of course, all the difference in the world between acknowledging a fact and accepting it. Acceptability is the first requirement for any long-pull military policy. Reasoned argument and the lessons of experience all too often have little or no chance of being accepted if they represent changes in established practice.

People have to get used to the idea of change. The tendency is to cling to the old ways as long as possible, partly from distrust of novelty, partly from sheer inertia, and partly because changing anything as ponderous and complex as the military policy of the United States inevitably costs money.

Consider what happened to the National Defense Act of 1920. In its original form it presented a thorough, carefully worked out military policy, representing the sound professional thinking of Brig. Gen. John McA. Palmer and the politico-military acumen of Senator James W. Wadsworth. It embodied the lessons of World War I, acquired at great cost. It included provisions for apportioning our military burdens among the Regular Army and citizen forces and for universal military training of all our young men.

But first the Democrats decided to oppose UMT as a party issue, so UMT was cut out of the bill. Then after the bill had passed the Senate, the House insisted on amendments that watered down the provisions even for training citizen volunteers.

FINALLY, the next year, after the passage of the emasculated bill, Congress cut the strength of the Regular Army from 280,000 to 125,000, which caused the deactivation of the corps area training centers and left us with little more than a lot of nice words filling up a few pages of the statute books.

A modern military policy just wasn't acceptable to the American people in 1920-1921.

Is it more acceptable today? Probably, but within limitations that have to be foreseen and understood. Look at the fate of the National Reserve Plan at the hands of the Congress just adjourned. The one point they still would not buy was UMT. In the years since 1920, UMT has become a symbol of nonacceptability. Some of the argument

in committee and on the floor of Congress was based, not on the merits of UMT, but on the bald assumption that "the American people don't want UMT," as though this were beyond discussion.

Incredible as it may seem, Congress proved willing to compel men who have already served two years as draftees to serve for a further period in Ready Reserve units, but was unwilling to compel young men who have performed no military service at all to enroll for a short training period and then serve in the Reserve. The latter was that bad thing, UMT. Therefore it was unacceptable.

The long pull means many things to many people. To the professional military officer, it means primarily enough men and weapons and money so that his unit or his branch of the service can perform its mission creditably. To the economist, it means maintaining a careful balance between the needs of defense and those of the civilian economy, or the financial structure of the Nation.

To the industrialist, it means a reasonable chance to make profits from his business, and government aid so that his plant can be ready to carry out whatever wartime mission may be assigned to it. To the educator, it means adjusting the need of the military services for manpower and the need of the Nation for skilled professional people, scholars, and scientists.

WITHIN all these walks of life—and many others—there are individuals, some of great influence, who hold diverse views on all these subjects. The man in the street is constantly subjected to the expression of these diverse viewpoints in the public prints, in radio and TV interviews, from the lecture platform, the pulpit, the literature of trade unions, and political debates.

In all these ways, as well as in private discussions ranging from breakfast tables to barrooms, is built up what we may call the climate of public opinion.

This climate is as important to the longevity of national policies as is natural climate to the longevity of plant life. It may nurture policy or wither it. The late Henry L. Stimson, asked by an anxious friend, "But what can I do as a single individual to aid the cause of national defense?" answered:

"Talk about it. Discuss it with your friends in your clubs, on the train, at home, and over the luncheon table downtown. It does not matter that they may not be convinced you are right. If you can only interest a few of them enough, pro or con, so that they, too, will talk about it with others, you will be helping to create an atmosphere of interest rather than one of indifference. In such an atmosphere, it is easier for public men to make wise decisions and more difficult for them to make wrong ones."

The atomic bomb has been accused of causing changes in the natural climate of our planet. It has most certainly been one root cause of the change that is taking place in the climate of American public opinion on the subject of national defense. The other root cause is recognition of the Communist danger to our free institutions.

These two added together—that is, dangerous Communists armed with dangerous nuclear weapons—combine in the mind of the American man in the street as a real and continuing threat to his country, his home, his family, his life, and the future of his children which he is willing to do something about, even at considerable sacrifice.

It is this change—from the indifference and complacency of 1920 to the accumulating anxieties of 1955—that makes it possible to think in terms of the long pull.

Is the change permanent? It has taken a generation for it to come about, and the new climate will not suddenly vanish in the sunshine of a new complacency tomorrow morning—of that we may be confident. Perhaps the two most serious facts for the architects of the long pull to consider today are (1) the need for planning a policy that will be—and remain—acceptable to other nations of the free world as well as to America, and (2) the effect on the climate of free world opinion, and therefore on national policies, of the blandishments of the Reds.

There would seem to be good reason to believe that a long-pull plan for our own national defense, if that could be considered without taking other free nations into account, might have prospects of stability extending for a good many years ahead, at least in its essential features.

THE sharp reaction by Congress and the press against the modest reductions in the size of the Army envisioned in the last budget is only one of many indications that large-scale national military power, absorbing the major portion of each year's public expenditures, has become an accepted fixture in our national thinking.

Anxiety arises now, not from fear of "militarism," but from fear of weakness. That's a hopeful fact, even if it has taken a generation of harsh realities to overcome the natural tendency of people to believe what they want to believe.

However, American national defense cannot be considered all by itself. As Lieut. Gen. James M. Gavin pointed out very cogently in a recent issue of ORDNANCE, our power is most effective when it is considered as the center of a world system—the "world-island" of North America, providing the military and industrial base for the outer defenses of the free nations all around the vast perimeter of the Communist Empire.

These outer defenses are vital to the defense of the central base against attack through the air with nuclear weapons. From the viewpoint of cold-blooded strategy that single fact is crucial, establishing once and for all our own interest in maintaining the security of the overseas positions. But from the viewpoint of continued participation in such a system by the peoples of Western Europe, or the Middle East, or of Japan, Southeast Asia and the Philippines, we must take into account the climate of their own public opinion.

That climate is not identical with ours, and it varies from country to country. It is not a climate in which American security is the principal ele-

ment, but rather the security of each individual nation and the individual human beings who collectively decide that nation's policies.

Many of these peoples have known, far more intimately and terribly than we, the ravages of war. They are not interested in being invaded again—especially by Communists—and subsequently liberated by the tardy arrival of the Yanks. They are most especially not interested in having their countries become the middle ground of a nuclear war between the United States and the Soviet Union.

They want no part of any war—they want most desperately to believe in the validity of any indication that there will be no war. Hence their national policies are more subject than ours to fluctuations based on wishful thinking and Communist garden parties. In so far as our long-pull planning is based on the participation of other peoples, we must remember that the lowest common denominator of acceptability throughout the participating states may be far below the level of what is acceptable to our own people.

FAILURE to recognize this fact and its implications for the future may lead us into formulating plans and translating them into material undertakings which will be useless to us either as deterrents or as ingredients of victory in war. A host of examples can be suggested: Can we count on the free use of our strategic air bases in Morocco five years from now? Can we be sure, in a Pacific war fought in 1965, that the Japanese would be both able and willing to defend their islands to the last gasp? Can we say with certainty that we shall enjoy unobstructed access to the Middle East through the Mediterranean for the next ten years?

Can we even be sure that the effectiveness of the NATO system will not undergo progressive deterioration as the threat which brought NATO into being appears to recede? We may believe that the recession is more apparent than real but what of its effect on the policies of nations whose peoples want so very much to believe that it *is* real?

Will reasoned argument be any more acceptable to them now than it was to our own people in 1920 when they were determined to believe in "Never again?"

Unhappily the Communist leaders—or at least the Soviet leaders—appear at long last to have become conscious of their ability to affect the climate of public opinion in some of the free countries. They appear to have emerged from the walls of the Communist intellectual prison, to have realized that the threats and bluster of Stalin's time served only to unify their opponents, and that a "friendly" attitude, sufficiently well publicized, might impair that unity to their advantage.

If the Soviet leadership presided over a vast national machine which it could manipulate at pleasure, stop, start, back up, or slow down, now and for the foreseeable future, without regard to the economic needs of its own people, the fear of nuclear war which resides in Russian as well as West European hearts, or the tenure of their highly uncertain jobs—then the situation would be even more threatening than it is.

But the Soviet government must take into daily account the climate of public opinion within the U.S.S.R. and the rest of the Communist world, however superior to ours may seem its ability to produce artificial changes in that climate from time to time.

We were astounded when postwar

revelations made clear to us the inner difficulties and dissensions of Hitler's Nazidom or those of Imperial Japan which we had accustomed ourselves to think of as monolithic machine-governments, impervious to such human weaknesses as fear, ambition, jealousy, and greed, to say nothing of love and hope—purring along on well-lubricated bearings with a relentless efficiency which our poor confused democratic stumble-bum government could never hope to equal.

Yet the basic theory of peace through strength, of which the long pull is only the military expression, is precisely that the democratic society wedded to the free-enterprise economy forms by all odds the strongest type of human association yet developed by mankind.

Therefore it follows that this way of life will prevail and will prove more attractive to a larger number of human beings than Communist tyranny. It is their system, not ours, which will eventually crumble away or undergo drastic change as a result of its inherent contradictions.

THUS the long-pull military policy—the policy of the military deterrent extended into the future—is far from being merely negative and preventative. In its essence it is much the same as Washington's "respectably defensive posture"—insurance taken out against aggression by a free people whose real victories are to be won elsewhere than on the battlefield.

But Eisenhower and those who may follow him will labor under burdens that Washington would not have had to bear even if the Congress of his day had granted all he asked. Washington could have established his defense system on the continent of North America alone. The time-space factors of today's air-nuclear-electronic-jet world deny us that privilege. Hence we need allies.

That being so, the success or failure of our long-pull military planning will depend on making it acceptable, not only to Americans but to other free peoples whose cooperation is necessary to its effectiveness. The disintegration of the military unity of the free world, and especially of the NATO alliance, is the gravest immediate danger we have to face. The enemy knows that, too, and will spare no effort, no chicanery, to drive home his wedges.

WHETHER we shall be able to counter these divisive efforts, to hold a nucleus of free nations together in a military association sufficiently well-knit and well-located to provide a "respectably defensive posture" in today's world, is the great unanswered question.

It presents a challenge to the hearts and minds of Americans—especially those called to positions of leadership—which is without parallel in our history. The danger of failure is very great—but the reward of success will be nothing less than the opening of the gateway to such a Golden Age as mankind has never before enjoyed.

Rocket Engines

They will power many of the missiles and aircraft of the future because of their ability to attain maximum performance at great altitudes where other engines fail due to the lack of needed oxygen

William P. Brotherton

Ryan Aëronautical Company, San Diego, Calif.

HELL hath no fury like a rocket engine. Heat, light, and sound explode from these man-made meteors with a magnitude that resembles an atom bomb blast.

Rocket engines live fast, dangerous, short lives. Fired with a terrifying "whoosh," they streak for space laden with destruction and trailing white-hot flames of incandescent gas. Men, watching their launching, call them "controlled catastrophes." Some observers say they never felt closer to death.

Rocket engines are so unique they live in a world of their own—both literally and figuratively. They are the hottest, fastest, farthest-ranging power plants conceived by man's mind. Rocket flame temperatures frequently hit 5,000 degrees Fahrenheit—heat in which most metals run like water. Rockets have traveled at 5,000 miles an hour—more than 1⅓ miles a second. Rockets have soared to 250 miles above the earth—where the air is so thin that each molecule travels more than a mile before striking another.

FOR years, rockets were Sunday-supplement fantasy. People refused to take them seriously. Then came the horrible black magic of the German V-2—fourteen tons of packaged disintegration hurled at 3,500 miles an hour for 220 miles and powered by a fantastic rocket engine that developed an equivalent of 600,000 horsepower, gobbling up 9 tons of fuel in 65 seconds.

Rockets are no longer hard to believe. They may make the heavy bomber and jet fighter as obsolete as muzzle-loading muskets. If enemy atom bombs are stopped short in mid-air, it will be done with rockets, powering guided and ballistic missiles.

Lieut. Gen. D. L. Putt, the U.S.A.F.'s Deputy Chief of Staff for Development, is not equivocal about rocket power. He says, "The question is not *whether* rocket engines will take the places of reciprocating and turbojet engines, but *when*."

Rockets are the "push" behind push-button warfare. Intercontinental missiles will have to fly outside the earth's atmosphere, where aërodynamic drag and lift vanish, to attain speed and range. Rocket engines are the only power plants which can streak into space because they don't "breathe" air.

Rockets pack other potent, unique advantages. All other aircraft engines lose thrust as they gain altitude. Rocket engine power increases with altitude, maximum thrust occurring in space when outside pressure is zero. Rockets take off at low speeds and thrusts in the dense air, close to the earth.

Because they consume fuel at a terrific rate, they lose weight fast in flight. As weight drops and thrust soars, rockets pick up speed like runaway locomotives. They attain maximum performance in the thin upper regions where it pays off most.

Rockets appear deceptively simple in design. They are not simple. Every facet of rocket design is critical. Because design is critical, the demands placed upon the manufacturer are extreme. All surfaces must be reproduced in homogeneous metal with machined and polished precision. Tiny imperfections can alter fuel flow and cause violent, unstable combustion.

Rockets are the only pedigreed power plants. Each is accompanied by a log containing a complete history of the particular engine's production and its behavior under flow tests. Most jet engines must be built to fine precision within close tolerances. Rocket engines must not only be built to exacting dimensions, but each engine also must be calibrated, like a delicate instrument, to avoid the variation in performance which even the smallest tolerance permits. This is a striking illustration of the effect of design on performance.

UNLIKE other engines which can be test run to determine their behavior, rocket engines are one-shot affairs. Once fired, they are consumed. To learn exactly how each engine will behave, in advance, Ryan Aëronautical Company tests them with water. Several tons of water per minute are gushed through the engine. The water is filtered so that

it contains no particles larger than .00025-inch. Pressures, volumes, and rates of flow are carefully measured.

These data are translated into actual fuel values by conversion factors which adjust for the differences in viscosities, temperatures, and other variables between the water and fuels used. Engineers then develop hydraulic characteristic curves which precisely chart the future performance of each rocket engine.

ROCKET engines fall into three basic types: (1) solid fuel; (2) monopropellant liquid; and (3) bipropellant liquid. All types carry their own oxygen supply for combustion purposes, either in intimate mixture with the fuel or as a separate component.

Solid-fuel rocket engines are widely used as boosters to assist airplanes and missiles into full flight, taking advantage of the fact that aircraft will fly with heavier loads and less thrust than they require for take-off. In these applications, rockets are secondary power plants, serving until ramjets, piston engines, or turbojets can take over.

Rato bottles are typical solid-fuel rocket engines. To launch the Ryan Firebee from the ground, a 10,000-pound thrust rato bottle boosts the target missile into the air. At sea level and with a velocity of 60 miles an hour, each 1,000 pounds of rocket thrust is equivalent to 300 brake horsepower.

Solid-fuel rockets are also taking a leading rôle in supplanting artillery and serving as the lethal punch for interceptor-type aircraft. They have two priceless advantages: (1) They have no recoil, and (2) They can be guided after launching. A 4.5-inch rocket packs the same destructive power as a 105-mm. howitzer. One man can handle the rocket launcher in contrast with the crew and heavy equipment required for the howitzer.

It is interesting to note that rockets originated as ballistic devices. They were first used by the Chinese in 1232 A.D. and were propelled by burning gunpowder. In the ensuing 700 years, rocket development lagged because it depended upon aërodynamic knowledge which could not be gathered until the advent of powered flight. Meanwhile, ballistic science made steady progress to push artillery ahead. Now, the trend is being somewhat reversed.

LIQUID-FUEL rockets are much more complex but more efficient and powerful than solid-fuel types. Some authorities estimate the practical limit for solid-fuel rockets to be fifteen seconds' duration. Above this, liquid fuel is indicated.

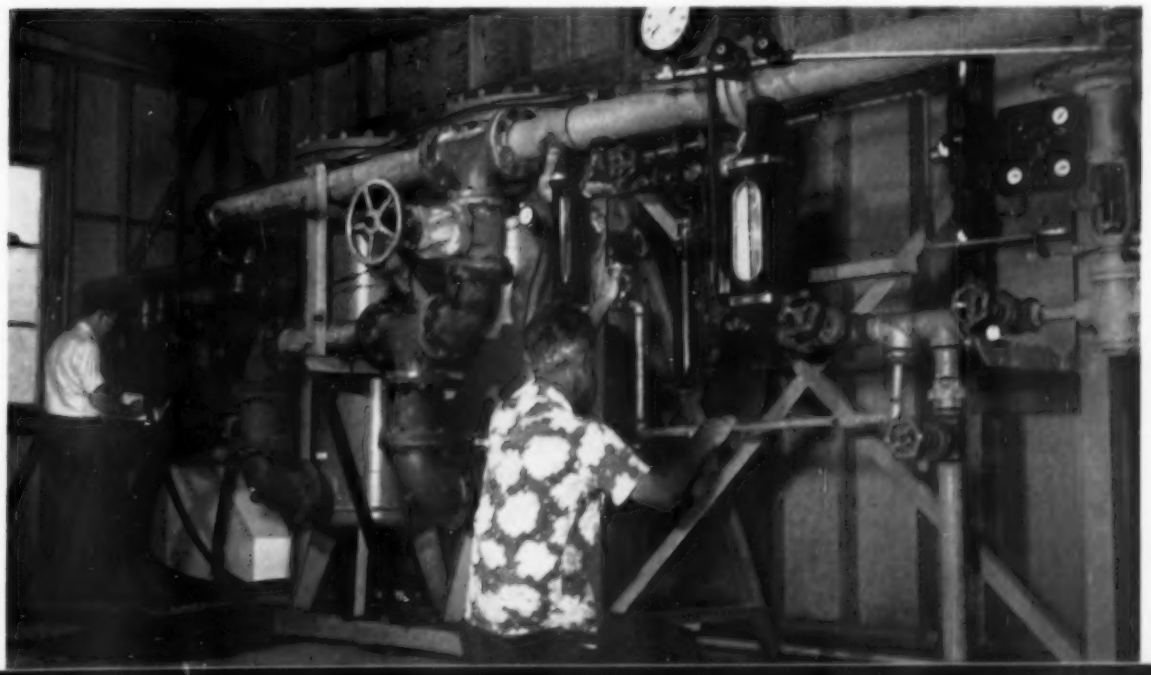
A complex array of automatic controls and valves is needed in liquid rockets. Huge volumes of liquid fuels and oxidizers must be injected into the combustion chamber at high pressures and under precise control. For example, in one rocket engine fuel-injection pressure must be raised to 700 p.s.i. to force the fuel into the chamber, at required rates of flow, where combustion pressure reaches 400 p.s.i. This power plant consumes 152.5 pounds of liquid oxygen and 123.5 pounds of alcohol a second.

DELIVERING large quantities of liquid at high rates of flow requires substantial power. This can be obtained from the energy of a compressed gas stored in tanks in the rocket or from powered pumps. For short durations, compressed-gas systems are suitable and lighter in weight. When extended duration is required, or high power is demanded, a pumping system is indicated. A rough estimate of the transition point where the weight of the pumping system will fall below the weight of heavy tanks is an impulse of 200,000 pounds a second.

Separate pumps are used for fuel and oxidizer. These are specialized, turbine-driven pumps which deliver extremely high flows at very low weight. In effect, small rocket engine chambers are used to expand gases through a turbine which drives the pumps. The rocket propellants are not used to generate the gases because the temperature of their combustion is so high that the turbine would have to be fabricated from heavier, high-temperature, creep-resistant alloys.

One ingenious source of turbopump power is hydrogen peroxide. When

Engineers chart a rocket engine's future performance by "firing" it with water while flow rates and pressures are measured.



mixed with a catalyst, calcium permanganate, it decomposes to liberate large quantities of steam. The steam delivers adequate energy to the turbine at moderate temperatures.

A major problem is to attain precision-controlled rates of flow from the pumps. This is influenced by the thrust developed by the rocket—which varies during flight; yet fuel and oxidizer must be injected in exact ratios and volumes to achieve smooth combustion at all times during flight. Unstable combustion can cause severe pressure fluctuations which will shake a rocket to pieces in split seconds.

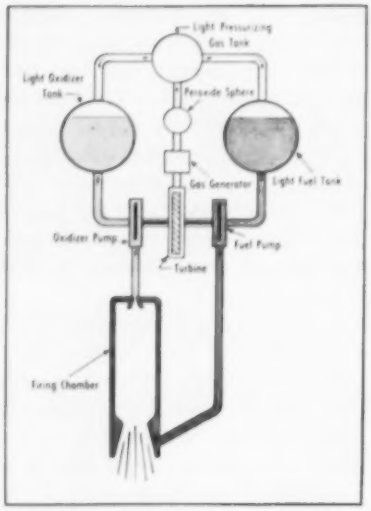
THE heart of the rocket engine is the combustion chamber. Here the fuel and oxidant are mixed and exploded. This is where the designer and manufacturer meet their first headaches.

Combustion chambers are usually cylindrical with an "hour-glass" shape. This is a compromise in which the ideal spherical chamber and converging-diverging exhaust nozzle are blended to fit space and fabrication limitations.

The geometry and volume of the combustion chamber are vitally important. The length of time that the fuel remains in the chamber is determined by chamber design and the ratio of its volume to the cross-sectional area of the nozzle throat. These factors must be balanced against the rate of burning of the fuel and the combustion pressure. Chamber volume, exhaust nozzle length, and exhaust cone angle must be delicately coördinated in design to attain specific thrust at a selected altitude.

ALL these considerations have to be made within the basic requirements that flame temperatures of more than 4,000 degrees Fahrenheit cannot be tolerated within the engine and that exhaust-gas velocity should be subsonic up to the nozzle throat, sonic at the throat, and supersonic in the diverging exit area.

Rocket engines are literally flying blast furnaces. The combination of high temperature, high pressure, and high gas velocity demands that huge quantities of heat be transferred or they would fuse the engine into a blob of metal within a few seconds after take-off. This problem is magnified by the lack of air which exists in the upper regions where rockets prefer to fly.



Basic elements of a turbopump system for a liquid propellant rocket engine.

Rocket design may require that as much as twelve BTU's per square inch per second be transferred from the combustion chamber. This is ten times as great as the heat flows encountered in the design of boilers and heat exchangers.

TO meet this torturing requirement, a number of ingenious stratagems are used. Rocket engine walls may be designed to be very thick in order that more heat can be absorbed before the melting point of the metal is reached. This confronts the manufacturer with the task of forming, welding, and heat-treating extremely heavy gauge materials. Thick walls alone will prolong rocket engine life for only a few seconds; other methods also must be employed.

Regenerative cooling, in which the fuel or oxidizer is circulated around the combustion chamber prior to burning, is one of the most successful of these methods. This technique also preheats the fuel to permit more efficient combustion.

To achieve best regenerative cooling, rocket engine walls should be made from metals of high thermal conductivity. Unfortunately, the metals with the best high-temperature properties all possess low coefficients of thermal conductivity.

Consequently, mild steel, or metals with rather low melting points, may be used in rocket engine fabrication.

In some engines, regenerative cooling alone is not enough. Temperature then is reduced by a "film cooling" effect. This is achieved by injecting coolant directly into the combustion chamber through small holes ringing the periphery.

IN most engines, the oxidant must be used for cooling purposes because insufficient quantities of fuel are available. The three principal oxidants are liquid oxygen, hydrogen peroxide, and nitric acid. Practical mixtures of these with rocket fuels mean that only when kerosene is employed as a fuel is there sufficient fuel to use for cooling. Otherwise, the coolant must be the oxidizer.

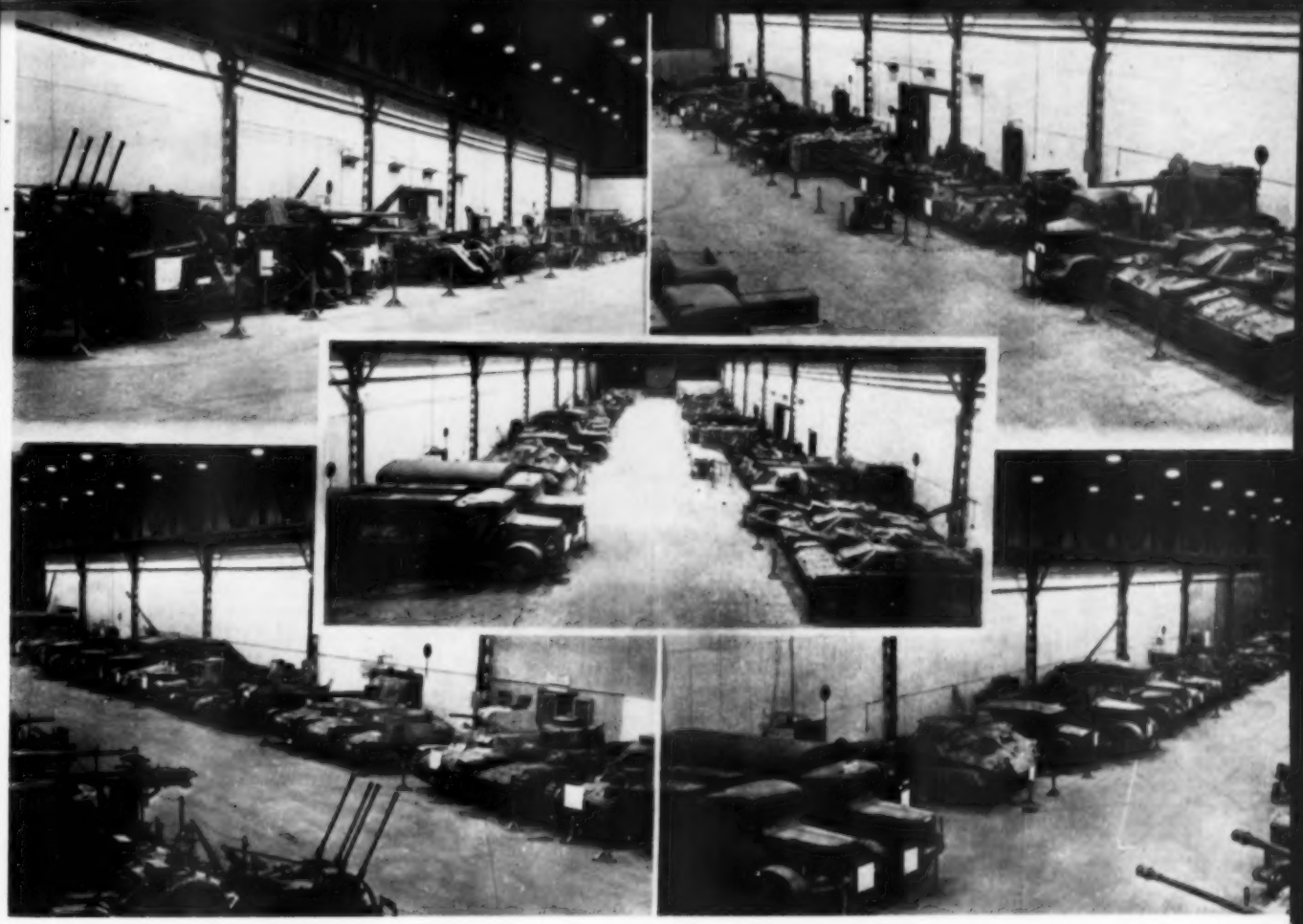
This adds headaches. Nitric acid readily attacks most metals with the exception of the stainless-steel alloys. Hydrogen peroxide decomposes into steam and oxygen in the presence of a catalyst, and many metals act as catalysts in this reaction.

Liquid oxygen is readily available but hard to store and handle. It reduces metal temperatures to 298 degrees below zero Fahrenheit, which is a mighty contrast to the temperature in the combustion chambers. This extreme subjects the chamber to terrific thermal expansion and contraction.

THESE are some of the basic reasons why the apparent simplicity of rocket engine design is misleading. Rockets are complex and destined to become more so.

If we continue in our relentless quest for more speed, the future of this power plant is assured. These are the only engines which can hurl us out of the earth's atmosphere where unlimited speed is possible.

This is not as far in the future as we might imagine. Even now, scientists assigned to specific rocket-propelled vehicles are working with celestial mechanics to solve the problem of bringing supersonic rockets back to the earth without having them explode from air friction like falling meteors.



The Ordnance Museum

A pictorial survey of the historical treasure house at Aberdeen

FOLLOWING World War I, much Allied and captured enemy equipment was shipped to Aberdeen Proving Ground, Md., for study and evaluation, thus contributing to American know-how resulting in many improvements to our own weapons.

This mass of matériel formed the nucleus for the Ordnance Museum at Aberdeen, today a storehouse of armament information. Under the dedicated guidance of Col. G. Burling Jarrett, curator of the Museum, the many weapons have been arranged and cataloged, facilitating ordnance research.

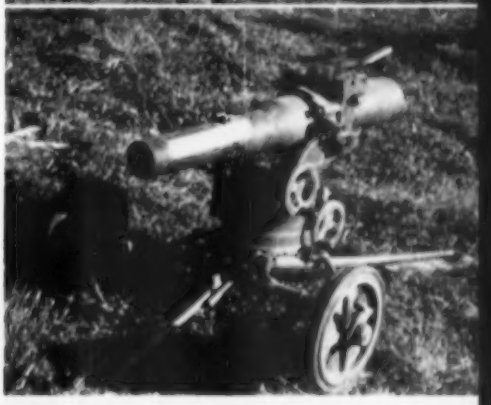
During World War II, Ordnance Technical Teams roamed the combat theaters and sent back to Aberdeen a great mass of enemy weapons. No piece was too large or too heavy, and foreign tanks and artillery poured into the Museum. New enemy developments were given special attention, such as the German recoilless gun, the Tiger tank, and the V-2 missile. Small arms also received their share of attention, and the Museum has a most complete collection of pistols, rifles, and machine guns from many nations.

The Ordnance Museum is not a mere static historical display. Its great value lies in the contribution it is able to make to the future security of America. Through study of the many weapons housed there, ordnance engineers will be able to unlock secrets of metallurgy, design, and production and to apply them to tomorrow's armament. In this way many hours of research and development can be saved, resulting in greater speed and economy in the perfection of our weapons. The Ordnance Museum is thus a powerhouse of historical fact and future information invaluable to the national defense.

Left, part of the original collection of captured World War I artillery which was shipped to Aberdeen Proving Ground in 1919 for study and research. It later formed the basis for the present museum.

Left, a prize display in the Aberdeen Tank Park is this St.-Chamond tank, manufactured and used by the French in World War I. This was the first such vehicle to mount an artillery piece, the now-famous French 75-mm. gun.

Right, a battle-scarred German King Tiger tank. Below, the German K5E gun, called "Anzio Annie" by U. S. troops in World War II. This powerful gun was the same caliber as our present 280-mm. cannon but lacked the mobility of the U. S. weapon. "Anzio Annie" was forced to rely upon highly vulnerable rail transportation (AP photo).



No matériel was too heavy for the Ordnance Technical Intelligence Teams to deal with during World War II and captured tanks like those shown above were shipped directly to Aberdeen for study and analysis in the ordnance research program. Below, Col. G. B. Jarrett and Mr. Karl Kempf, who are in charge of the Museum displays, inspect part of the small arms on exhibit. Right, top to bottom, a German 12.8-cm. antitank gun; tube of the German 54-cm. "Thor" artillery piece; a German 7.5-cm. recoilless gun taken after the Battle of El Alamein in 1942; an original French 75-mm. gun, model 1897. All field guns are displayed in an outdoor setting at the special Artillery Park, Aberdeen Proving Ground, Md.

Below, the German 17-cm. gun with 360-degree traverse introduced the principle of double recoil during World War I.

Left, an Italian medium tank captured during the North African campaign of World War II and now on display at Aberdeen.

Right, the British Mark IV tank, one of the now-famous British weapons which initiated the present era of armored warfare.

Left, part of the indoor display of field weapons captured during World War II and sent to the Aberdeen Museum for study.

Logistics Today

A combined military-civilian effort is needed for the efficient production, supply, and maintenance of modern arms and equipment in order that the United States may always be effectively defended

Brig. Gen. T. A. Weyher and Dr. B. K. Zobrist

WITH the beginning of the First World War a veritable revolution was loosed in the ancient business of fighting. Basic to this sweeping change was the development of precision manufacture and mass production—methods destined to give impressive superiority to American technology.

Eli Whitney, Simeon North, Samuel Colt, and other early nineteenth-century Americans share the credit with certain British inventors for the first use of the system of interchangeable-parts manufacture, the key to mechanized mass production.

Introduced into the field of firearms, this method of manufacture spread to other parts of industry, later accomplishing its most notable results in the making of automobiles and airplanes. And in these industries the application of the internal-combustion engine to transportation created the other prime factor most profoundly affecting the logistics of modern warfare.

By the time the First World War ended, nearly all the elements for mechanized warfare were in existence. The Second World War gave full realization to the scientific and technological revolution. Here the great scientific mass-production developments of previous decades culminated in the application of huge industrial potential to military needs.

The ability of Americans to produce war matériel in vast quantities and to manage large supply lines enabled our combat forces to apply the military principle of mass in a manner never before witnessed. Indeed, logistics, in large degree had supplanted strategy and tactics in over-all importance. Today the provisioning of military forces is a vast and complicated operation.

General Weyher is commanding general, Ordnance Weapons Command, Rock Island, Ill., while Dr. Zobrist is historian with both the Ordnance Weapons Command and Rock Island Arsenal, Ill.

The new approach to warfare has profoundly influenced every aspect of the military fields of armament and munitions—research, development, production, distribution, and maintenance. Basically, modern combat, as does modern civilization, owes its present state largely to the cumulative body of knowledge called science.

From the steam engine to jet propulsion and television, every inventor and every mechanical contrivance has been indebted to some prior scientist or to an earlier accumulation of basic scientific data.

Of extreme importance to our present military situation is the time lag between the discovery of fundamental knowledge and its application to the solution of everyday problems which, according to some writers, averages forty years. At this critical juncture, the military meet head-on the pressing need for the development of new weapons and improvement in the arts of war.

Moreover, it is becoming increasingly evident that a nation which depends upon others for its new basic scientific knowledge will be slow in its progress regardless of its mechanical ability.

In January 1951 the Department of Defense issued a policy statement that recognized basic research as the essential foundation for all military applied research and development.

RATHER than drive basic investigation underground to be hidden within applied research or development projects, the military services are now embarked upon a comprehensive program supporting abstract study both within the armed services and in colleges, universities, and endowed research institutions.

Unquestionably, the recognition and application of mature basic knowledge to weaponry has become a matter of utmost significance to logistics.

In the field of development, scientists and engineers must discern possible applications of basic knowledge to the needs of military equipment while keeping in mind the current state of manufacturing ability.

New matériel must coincide with the technical capabilities of production.

For example, no development program launched in 1861 could have been more sterile than one requiring a supply of tanks for either of the belligerents.

While the principles of the steam engine and caterpillar treads were known, the state of mechanical knowledge at the time simply could not make practical the design and production of such a weapon in quantities to be effective.

Neither can the complexity of a weapon exceed the capability of the average soldier to operate it effectively with the amount of instruction time will permit him to receive. Functional designs of extreme simplicity and ruggedness are the objectives toward which development strives.

THE incorporation of these features in the creation of weapons in the relatively safe, well-equipped zone of the interior has for its purpose the reduction of the amount of field maintenance under attendant adverse conditions as well as the reduction of large quantities of spare parts for repair purposes.

The ultimate goal of weapons design —now largely in the realm of wishful thinking—is the complete elimination of field maintenance.

Development occasionally perplexes the civilian manufacturer of a new weapon who may set off a great hue and cry about unnecessarily close tolerances and who is prone to avoid adhering to these tolerances. He fails to realize that in warfare second best is not good enough.

We must meet maximum requirements, not minimum requirements.

Precision in artillery, for instance, accomplishes two things: greater accuracy of fire and longer life for the weapon. Since approximately eight to ten times the value of the gun is expended in the shells it fires, manufacturing precision which will reduce the scatter of shots by half and therefore ammunition expenditure by half is worth the effort to attain.

Furthermore, considering the great difficulties and expenditures incurred in spare-parts distribution, the extra life of the weapon can easily justify the added cost of greater precision.

Careful planning at the development stage of any item of matériel can avoid many costly expenditures in logistical support required by later revision and replacement of poorly engineered parts.

The military supply manager for a peaceful, democratic country finds himself on the horns of a dilemma. Since the aggressor selects the time and the place of attack, prudence dictates that sufficient military supplies be in reserve at all times.

Inasmuch as many military items require considerable time for manufacture, a very sizable reserve of equipment is needed for a rapidly expanding military force during the period when industry is converting to war production.

Still the conception of technologically superior weapons by vigorous, dynamic research and development programs does much to minimize the numerical superiority of any possible enemy in modern warfare. New metals, plastics, antibiotics, chemicals, and other products of the laboratories are continually modifying older weapons and introducing new ones.

And there is no reason to believe that this constant influx of new or improved materials will stop. Indeed, if our superiority in arms and equipment is to be maintained, it cannot stop.

Paradoxically, long production lead time makes desirable a large reserve, but the rate of obsolescence of the reserve suggests a diametrically opposed course of action. What is the answer?

The most feasible solution is suggested in a combined military-civilian effort. This is the concept presently governing our military preparedness. In this joint undertaking, the Nation's arsenals, kept at a peak of effectiveness, are ready on a moment's notice to assert technical leadership in the production of munitions of war and to help train industries unaccustomed to producing military goods.

"The function of distribution must assure the availability of weapons, ammunition, and parts at the time and place and in the quantity needed throughout the supply system."

THESE Government manufactories comprise the first link in the combined effort. The reactivation of standby Government plants, ready for production as rapidly as labor resources can be assembled, and the reconversion of the remaining portion of industry previously assigned military-production missions, both complement and supple-

ment the functions of the arsenals.

By this method of preparedness, the level of reserves can be kept lower and the military services can take full advantage of the advances of science in the field of weaponry. The system entails many problems of an economic nature, but it is in all likelihood the optimum logistical solution in terms of time, money, and security.

Once the matériel of war has been manufactured, the function of distribution must assure the availability of weapons, ammunition, and parts at the time and place and in the quantity needed throughout the supply system. The magnitude of this task has no commercial counterpart. Most of the problems in military supply management arise from this fact.

The organization, methods, and techniques commonly used in business fall far short of a modern military supply system's needs.

TROUBLE often ensues from the adoption of civilian business methods as the solution for military problems without full appreciation of all the factors involved.

The military supply problem is unique for many reasons:

1. The inability to judge future needs because wars are too brief to allow the supply flow to reach a "steady state" which would provide reliable statistics for future projection.

2. The necessity of operating a vast, complex supply system with partially trained personnel—men who have never had a chance to develop intuitive familiarity with the supplies they handle and the peculiarities of their partially trained customers.

3. The lack of reliability of war-ravished transportation nets.

4. The apparent necessity for frequent displacement of large tonnages of field depot supplies.

5. The need for developing a boxing, crating, and packaging system that will ensure usable supplies reaching the hands of troops so that their markings are legible enough for identification.

During World War II the number of different spare parts rose to 750,000 in the Ordnance supply system. Thousands of commercial-type parts were brought into the system. They were identified by the parts numbers of the initial engineering drawings, of the vehicle manufacturer and assembler, and of Army Ordnance.

"Recognition of the importance of logistics in the art of war is not new. What is new in the United States military services, though, is the growing conviction that logistics deserves special attention at all echelons of command. Army schools are now devoting greater attention to this subject."

Obviously, the system became quite confused. In extreme cases identical parts were found stocked under as many as twenty-six numbers. This meant twenty-six separate warehouse locations if the cross-reference system failed. Parts were denied to a requisitioner under one number, when, if only known, the part might have been supplied under another number.

Moreover, caches of stock in numerous depots and other installations in the zone of interior, in various so-called unit loads carried by combat troops, and in depots and other supply points in the theater of operations caused a terrific attenuation in matériel between the points of manufacture and actual consumption.

Under these conditions, nonrecurrent initial issues of parts were easily confused with the normal consumption of parts. Such confusion reflected high consumption rates, which, when projected against an ever-increasing troop density, resulted in vast overprocurement.

A business having the necessary capital to carry such an overage could eventually work off such a swollen inventory. In the military services, however, this is a most serious problem since critically needed manpower, material, and transportation, as well as time are expended in producing unneeded supplies.

These are only a few of the larger problems of logistics faced by the military distribution system.

With progressing intensity, the enigma of logistics has plagued military planners from the beginning of warfare. And in the present highly technical state of combat, logistics is increasingly overshadowing the importance of strategy and tactics. All our twentieth-century wars have emphasized the need for understanding the ramifications of logistics.

The less said about the logistics of the Spanish-American War, the better. The British, after the Boer War, found it advisable to overhaul and reform their whole army organization.

The Russo-Japanese War of 1904-1905 presented huge logistical problems for both combatants. The Russian war effort was entirely dependent on a single line of railroad—the Trans-Siberian. The Japanese, too, were so exhausted after the final indecisive battle of Mukden that they were glad and, by the way, fortunate, to make peace with a foe who had no heart in the struggle and had not yet put one-tenth of his available forces into it.

In 1914 the successfully launched Russian campaign against Austria eventually failed because of inadequate logistical support.

WHEN the Central Powers finally collapsed, it was not because of lack of money or manpower but because of the lack of essential commodities. Similar illustrations can be drawn from other modern conflicts.

Recognition of the importance of logistics in the art of war is not new. What is new in the United States military services, though, is the growing conviction that logistics deserves special attention at all echelons of command. Army schools are now devoting greater attention to this subject.

Recently, the Department of the Army established the Office of the Assistant Secretary for Logistics and the Deputy Chief of Staff for Logistics—the latter exercising command over the Army's seven technical services. The plan envisages a systematic career development for logisticians, something quite new to the American Army.

Only by observing the importance of logistics can the United States Army defend our Nation efficiently and effectively under present circumstances.

Maj. Gen. E. L. Cummings, USA

Maj. Gen. J. B. Medaris, USA

Maj. Gen. W. D. Eckert, USAF

Rear Adm. J. H. Ward, USN

Rear Adm. C. K. Bergin, USN

Liaison with the Services

Committees have been established by the Army, Navy, and Air Force to coöperate with the American Ordnance Association in fostering a mutual understanding of the problems of industry and the services

A liaison committee has been established by each of the armed services to strengthen the close tie between industry and the ordnance or armament personnel of each service through the American Ordnance Association.

It is expected that these committees will be of great value in industry-ordnance relations by bringing into focus many of the military production problems that American industry is able and eager to solve.

The liaison committees are not to be confused with the service personnel who are advisory committee members in the many Technical Divisions of the A.O.A. The latter members operate in the field of their specialty whereas liaison committees members will advise in the broad area of matériel problems and are prepared to advise their own service activities on the most effective A.O.A. Technical Committee to consult in a specific field.

In a like manner A.O.A. industry members can furnish guidance on many problems particular to one service.

The officers of the committees as presently assigned are all on duty in the Washington, D. C., area which facilitates communication with A.O.A. national headquarters.

Capt. G. B. H. Stallings, USN

Capt. T. H. Morton, USN

Capt. H. B. Lyon, USN

Capt. F. D. Karns, USN

Capt. B. L. Lubelsky, USN

Col. J. M. Stark, USA

Col. H. G. Jepson, USA

Mr. R. W. Cuthill

Col. A. M. Smith, II, USA

Col. J. G. Shinkle, USA

All members of the three committees were welcomed at an informal luncheon at the Mayflower Hotel after the fall meeting of the Executive Committee of the American Ordnance Association on September 15th.

ARMY.—The Army committee members, under the chairmanship of Maj. Gen. E. L. Cummings, Chief of Ordnance, are all on duty in the Office of the Chief of Ordnance. They are:

Maj. Gen. J. B. Medaris, Assistant Chief of Ordnance, Chief of Industrial Division.

Col. John G. Shinkle, Executive Officer, Research and Development Division.

Col. A. Mark Smith, II, Chief, Requirements Branch, Field Service Division.

Lieut. Col. Thomas W. DeMint, Technical Liaison Officer.

Col. John M. Stark, Chief, Industrial Operation Branch, Industrial Division.

Col. Hans G. Jepson, Assignment of Logistic Responsibilities, Office of Program Coördination.

Mr. Robert W. Cuthill, Chief Engineer, Industrial Division.

NAVY.—Members of the Navy Liaison Committee, under Rear Adm. James H. Ward, have been appointed from each of the operating divisions of the Navy's Bureau of Ordnance. They are the following:

Rear Adm. C. K. Bergin, Assistant Chief of Bureau for Research and Development.

Capt. G. B. H. Stallings, Assistant Chief of Bureau for Material.

Capt. F. D. Karns, Director, Quality Control Division.

Capt. H. B. Lyon, Assistant Director of Material for Maintenance.

Capt. B. L. Lubelsky, Director of Budget and Facilities, Research and Development Division.

Capt. T. H. Morton, Program Director, Navy Ordnance Weapon Systems.

AIR FORCE.—Maj. Gen. William D. Eckert heads the Air Force committee whose members are on duty either in the Office of the Deputy Chief of Staff for Development or for Material. They are:

Col. R. L. Johnston, Assistant Director of Research and Development, Office, Deputy Chief of Staff, Development.

Col. D. E. Riley, Chief, Equipment Division, Directorate of Procurement and Production, Office, Deputy Chief of Staff, Material.

Lieut. Col. Gerald Couch, Deputy Chief, Armament Division, Directorate of Supply and Services, Office, Deputy Chief of Staff, Material.

Lieut. Col. Thomas B. Joyce, Directorate of Research and Development, Office, Deputy Chief of Staff, Development.

Lieut. Col. James D. Frye, Office, Deputy Chief of Staff, Material.

Col. D. E. Riley, USAF

Col. R. L. Johnston, USAF

Lieut. Col. Gerald Couch, USAF

Lieut. Col. T. B. Joyce, USAF

Lieut. Col. J. D. Frye, USAF

General Maxwell D. Taylor

Chief of Staff, United States Army

will be the honor guest and

principal speaker

at the

Annual Industrial Preparedness Dinner Meeting

of the

American Ordnance Association

to be held under the auspices of

The New York Post of the Association

in the

Grand Ballroom of the Waldorf-Astoria

New York City

Wednesday, December 7, 1955, at 7:30 p.m.

Black tie *Guests may be brought*

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At 10 a.m. and again at 2:30 p.m. on the Starlight Roof of the Waldorf there will be seminars on The Scientific Bases for Weapons at which papers will be presented by leading authorities representing the Army, Navy, Air Force, Atomic Energy Commission, Harvard University, and the National Advisory Committee for Aëronautics. Luncheon on the Starlight Roof will be addressed by leading spokesmen for American Industry.

Reservations will be accepted until Wednesday, November 23rd, if seating space still permits. All surplus of receipts over expenditures connected with the meeting will be donated to the Army Relief Society.

Are We Ready?

It is believed that the Nation's preparedness can be determined from an analysis of a small group of factors representing its political, economic, moral, industrial, and military strength

Col. Hans G. Jepson

IF some one asked you bluntly, "Is this country ready for war and, if not, where is it lacking in strength?", what would be your reply? I probably would parry with counter-questions such as "What kind of war, with whom, and how soon?" I might even remember a few of the theories set forth by various protagonists who, depending upon their favorite specialty, would extol one or the other of single factors as being the only accurate ones to measure a nation's military strength. But at best these factors supply us with only part of an answer to a most complex question.

If we had a yardstick that could measure accurately how fully and how sincerely a nation is following the Ten Commandments then, in the opinion of the author, we would have an excellent measure of that nation's war readiness. That is so because a devout nation is motivated by a just and common cause which gives it strength and courage.

PRESIDENT Dwight D. Eisenhower clearly and forcefully expressed that principle in his State of the Union message to Congress in January 1954 when he said:

"So long as action and inspiration humbly and earnestly seek favor in the sight of the Almighty, there is no end to America's forward road; there is no obstacle on it she will not surmount in her march toward a lasting peace in a free and prosperous world."

Colonel Jepson is currently assigned to the Office of the Program Coördinator, Office, Chief of Ordnance, Washington, D. C.

But presently known yardsticks do not enable us to measure national compliance with the Ten Commandments. The usual measure of war readiness of a nation includes its relative strength compared with that of other nations being considered.

But zealous and conscientious as is this game of assessing relative strengths of nations, there apparently is no formula, no pattern, no scale that even the experts can use to get an *exact* measurement of a nation's strength or war readiness. If this be the case we obviously are dealing in the realm of an inexact science, which after all is the real category of war.

Since cold or hot war is never static in the true sense, our estimate of a nation's strength must be constantly reviewed in the light of the changing situation or it would soon be meaningless.

Such continuous review entails fantastic time and effort if all the thousands of factors comprising a nation's war readiness are fully analyzed and evaluated. And even before one is partly through the computation the situation has already changed.

The inaccuracy of the final answer by this ponderous method completely eclipses the accuracy of the data and exactness of computation being used. One approaches the grievous situation in mathematics wherein the computation demands decimal accuracy of figures which themselves are only approximations.

ON the other extreme we find the advocates of single-factor evaluation of a nation's strength or war readiness. Here too, one can go far astray because of the complete improbability that any one factor will be a true measure of national strength. As is so often the case, the logical solution is somewhere between these extremes.

It is apparent that if we could select a small group of factors representative of a nation's political, economic, moral, industrial, and military strength and could evaluate that group with reasonable accuracy as a measure of that nation's readiness for war, we could reduce immeasurably the man-hours usually applied toward a solution. At the same time we would not be relying solely on the precarious single-factor approach.

It has been the author's belief that such a small group of factors could be selected and could be evaluated with a degree of accuracy at least in consonance with the accuracy of the economic data normally available to us.

Search for the group of factors fin-

ally resolved itself into a study of history to find out what factors played a dominant and consistent rôle in the military life of nations. Selection of these factors and the presentation of a formula in which to use them in the determination of our readiness for war is the objective of this article.

THE group of representative factors was actually selected by two methods. One through a study of historical records of wars and battles and the other by monitoring the written expressions of prominent men who had studied various aspects of war readiness and national strength. From this approach a pattern should evolve if there is any consistency at all.

The above approach did pinpoint attention, through repetition, on certain factors which apparently play a dominant rôle in warfare. When one looks back in history and studies wars and battles these same factors appear time and again to determine defeat or victory. Thus they provide us with a clue to the elusive group of factors that we are seeking and which, when properly appraised for a nation, we believe will give us a reasonably accurate evaluation of that nation's ability to defeat an aggressor.

Even though we select such a group of factors we must never overlook the fact that history has innumerable examples indicating that the results of wars and battles often hinge on strange coincidences which are but the vagaries of fate and cannot be foreseen. For such as these we can only make allowance within the limits of our means and bear the burden of uncertainty as a calculated risk.

IN selecting the group of factors, approximately 300 wars and battles were analyzed covering the period from Marathon in 490 B.C. to the United Nations' police action in Korea in 1950 A.D. It is conceded that many times the recordings of history left much to the imagination. Failure to recognize this could easily place us in the unenviable category of judiciously avoiding small errors while blithely sweeping toward a grand fallacy.

However, it is believed that the shortcomings of historical data have been acceptably minimized through analysis of the relatively large number of wars and battles. Further, it is not claimed that the selected factors are capable of high mathematical accuracy in their portrayal. It is merely hoped that they are representative and, within their limits of accuracy, will enable us to sample the ingredients of a war economy and to evaluate the war readiness of our resources.

MAJOR WAR READINESS FACTORS	WARS AND BATTLES			WARS ONLY		
	Defeat (per cent)	Victory (per cent)	Prime Defeat Factor (per cent)	Defeat (per cent)	Victory (per cent)	Prime Defeat Factor (per cent)
Manpower	41	46	53	31	39	50
Raw Materials	16	11	50	46	31	50
Industrial Resources	24	24	78	69	69	78
Technology	43	46	63	62	62	50
Time	49	43	44	46	31	33
Mil. Inst., Forces and Eq.	51	57	79	46	54	50
Fuel and Power	14	11	20	39	31	20
Transportation	68	51	56	85	85	55
Morale	35	60	62	15	54	50
Money	14	19	0	39	46	0
Politics	46	32	41	39	31	20
Collective Security	41	35	60	31	31	75
Civ. Housing and Goods	0	3	0	0	8	0
Public Opinion	16	41	0	23	31	0
Organization for War	43	51	25	69	69	22
Civil Defense	19	19	43	39	15	20
Food	43	22	31	54	54	29
Communications	68	73	52	54	77	29

Table 1. Significance of the war-readiness factors in defeat or victory.

THE group of eighteen factors decided upon as being representative of the thousands of factors which constitute a nation's war readiness is as follows:

Manpower.—This factor in its broadest sense includes all persons in the nation capable of performing any nationally useful effort. It includes men and women, old people and children, physically fit and handicapped, military and civilians.

Raw Materials.—This factor includes the basic products of mine, well, soil, and sea (other than fuels). Obviously our production miracles cannot be performed without basic raw materials.

Industrial Resources.—This factor includes the factories, shops, and machine tools in being, industrial or manufacturing techniques, managerial "know-how," and the over-all industrial structure. Our study of past wars and battles has brought out the consistent significance of the industrial resources factor, especially in prolonged wars.

Technology.—This factor refers to man's control over his natural environment through application and utilization of scientific knowledge in the practical arts and sciences. Obviously we cannot consider technology in the military sense to the exclusion of it in other fields. It has been a significant factor in military history all the way from arrow to atom bomb.

Time.—This factor is assumed to be finite and to signify a portion of duration suitable, available, or sufficient fully to prepare a nation for war or to deter an aggressor.

Military Installations, Forces, and Equipment.—This factor includes all military installations in being and all the combat-ready units of the Army, Air Force, Navy, and Marine Corps; also, all military equipment in the supply pipeline, in the hands of troops, on ships, or in aircraft. We can no longer depend on time and geographic location to cushion the initial shock of a sneak attack by a ruthless aggressor. We must have in being some military forces, a substantial stockpile of military weapons strategically dispersed, and sufficient military installations to enable us to wage a vigorous war even though initially crippled severely by attack.

Fuel and Power.—This factor includes all energy sources and resources utilized for the production of power. If indus-

try is vital to war and power is vital to industry we must of necessity conclude that power is important to the winning of war.

Transportation.—This factor includes water, railway, highway, air, and pipeline methods of transportation.

Morale.—This is an extremely important factor since it obviously must include motivation of both the individual and the Nation. Without proper motivation we cannot have sustained morale.

Money.—This factor covers the stability and flexibility of our monetary system rather than the medium of exchange itself. It includes the Treasury, the Federal Reserve System, commercial banks, and our credit and banking system.

Politics.—This factor covers the domestic political situation relative to its organization, stability, reliability, opposition, representation, acceptance both at home and abroad, and motivation.

Collective Security.—This factor is assumed to mean the coöperative efforts of nations, or groups of nations, against aggression or the threat of aggression. It is sometimes referred to as "power politics." Its importance has been repeatedly evidenced throughout the course of military history.

Civilian Housing and Goods.—This factor includes civilian housing and consumer goods in being and available to the public. Manufacturers', wholesalers', and retailers' inventories would be a part of these goods. The distribution system for consumer goods is also included.

Public Opinion.—This factor is assumed to mean the sentiment or belief of the masses in regard to both preparation for war and the impending war itself.

Organization for War.—This factor includes the mechanism within our Nation for formulating and carrying out our national military policy. By very definition this implies both governmental and civilian organization and the key personnel with which they operate.

Civil Defense.—This factor includes the Federal, State, and local organizations, their facilities and their procedures as applied to the over-all civil defense program. Also included are such things as dispersion of industry, local security, and coördination with military defense and surrounding target areas.

Food.—This factor includes foods of all types, the agricultural resources and facilities to produce food, and the industrial facilities to process it. It also covers such items as mechanization of agriculture, increased yields through use of fertilizers, improvement of seed strains, planting techniques, and reclamation and conservation of lands.

Communications.—This factor includes all major means of transmitting information from one place to another. It covers such means as wireless, wires, printed matter, motion pictures, and television. Also included is our intelligence system, both economic and military, since such information is extremely important to war readiness.

SPACE will not permit detailed discussion of the many facets connected with the evaluation of these factors. Each obviously cannot have equal value in a formula. The significance of the various factors based on our study is shown in Table 1. In evaluating the data collected we must not lose sight of its nonpreciseness.

It is proposed herein to recognize the historical data only in its general applicability and to utilize it as a guide in giving weighted significance to war-readiness factors for current usage. By utilizing the data in this manner our reasoning is not shackled by precise mathematical calculations that have their place in the exact sciences, which this is not, and cannot be by its very nature.

In order to give a numerical weight to each of the eighteen war-readiness factors a constant has been applied. This constant is in proportion to the defeat or victory significance of the factor in past wars and battles. In addition, the factor has been weighted in proportion to its dominance as a prime defeat factor wherever applicable.

THE weighted values for the factors are shown in Column 2, Table 2. For formula use, each factor also has been given a letter designation as shown in Column 1, Table 2. The factors have been placed according to the descending value of the weighted constants. Each factor in itself will be considered as unity; *i.e.*, have a maximum value of 1.00 when considered without its weighted constant. The value 1.00 is used to enable stating Factor War Readiness as a percentage. Thus the value 1.00 in Column 3 of Table 2 indicates 100 per cent war readiness.

Our entire approach is based on the premise that war readiness is measured in terms of full mobilization and

Table 2. Weighted value of the major war-readiness factors.

MAJOR WAR READINESS FACTORS	1 Letter Designation of Factors X	2 Factor Constant k	3 Max. Value of Factor Elements	4 Critical Value of Factor Elements (M-Day)	5 Disaster Value of Factor Elements
Industrial Resources	A	54.0	1.00	0.55	0.25
Transportation	B	48.0	1.00	0.60	0.30
Mil. Inst., Forces & Eq.	C	45.0	1.00	0.60	0.25
Communications	D	40.0	1.00	0.65	0.35
Technology	E	39.0	1.00	0.70	0.45
Morale	F	37.0	1.00	0.8	0.40
Collective Security	G	31.0	1.00	0.40	0.20
Manpower	H	24.0	1.00	0.35	0.20
Raw Materials	I	23.0	1.00	0.50	0.25
Time	J	22.0	1.00	0.75	——
Politics	K	19.0	1.00	0.35	——
Organization for War	L	17.0	1.00	0.80	0.35
Civil Defense	M	17.0	1.00	0.70	0.35
Food	N	17.0	1.00	0.50	0.25
uel and Power	O	8.0	1.00	0.60	——
Money	P	0.5	1.00	0.25	——
Public Opinion	Q	0.4	1.00	0.65	——
Civ. Housing and Goods	R	0.1	1.00	0.40	——

all-out war; further, that our over-all national objective in case of war is victory. And to be on the safe side, we must measure our readiness against a sound national war plan. This presupposes that the national war plan has adequate posture to provide a reasonable national security in that it integrates our national war objectives into our national capability.

FURTHER, we must recognize that M-Day can be today, tonight, or tomorrow at the whim of a ruthless aggressor. And, since we can no longer claim time and geographic location as our dependable allies in a long build-up toward a mythical M-Day, we are now forced to measure our war readiness against the planned build-up for M-Day of the war plan. Here we are not attempting to measure war potential but only war *readiness*.

It will be recalled that in past wars we gambled with various plateaus of war readiness in a sort of creeping mobilization. Modern atomic weapons and aggressor threats now make such a gamble too dangerous. That is why we have selected M-Day build-up for an all-out war as the point against which we measure our war readiness.

The critical values of factors in Column 4, Table 2 are empirical in origin. They indicate the danger point below which value we must consider the war-readiness factor as being seriously deficient. Our research also has indicated that if *any seven* of the eighteen war-readiness factors are deficient (equal to or below the critical values in Column 4, table 2) then we can expect to be defeated in a war with a major enemy.

Column 5, Table 2, indicates the disaster value for the factors. It will be noted that disaster values are applicable to only twelve of the eighteen factors. However, these twelve generally can be considered indispensable to the extent that if the factor gets below the given minimum for *any one* of these twelve we may be courting a military disaster. These values are also empirical in origin. The reader is again reminded that the value 1.00 in Column 3, Table 2, represents 100 per cent war readiness for the factor in that it meets full requirements for M-Day of the national war plan.

"It is apparent that if we could select a small group of factors representative of a nation's political, economic, moral, industrial, and military strength and could evaluate that group with reasonable accuracy as a measure of that nation's readiness for war, we could reduce immeasurably the man-hours usually applied toward . . . a solution."

We have, so far, selected a group of eighteen war-readiness factors and have given a weighted value to each factor constant (Column 2, Table 2). In Columns 4 and 5 of Table 2 we have listed, respectively, the critical and disaster values for the eighteen factors. We are now ready to develop the formula.

As in most things, the simple solutions are generally the best for all-around usage. Simplicity is the objective in this formula. We merely add the individual factors, after first multiplying each factor by its weighted constant. This sum will be the *War Readiness Number*. Our general formula can thus be stated in the following terms:

Let W = war-readiness number of a nation.
k = a constant (refer to Column 2, Table 2).
X = a war-readiness factor (refer to Column 1, Table 2, A through R).
n = any positive number.
Xn = any number of war-readiness factors.

$$W = k_1X_1 + k_2X_2 + \quad k_nX_n$$

Substituting in the above, for our 18 factors the formula becomes:

$$W = 54A + 48B + 45C + 40D + 39E + 37F + 31G + 24H + 23I + 22J + 19K + 17L + 17M + 17N + 8O + 0.5P + 0.4Q + 0.1R$$ and

$W = 442$ if each of the 18 factors A through R equals 1.00; (Number 442 thus indicates 100 per cent war readiness because all factors have maximum value. This situation is only rare unless we resort to wishful thinking.)

Now let W_c = critical war-readiness number of a nation. Then multiply each weighted factor by the critical values given in Column 4, Table 2. By adding we get:

$W_c = 263$ (Number 263 indicates that war readiness is critical and needs improvement. This number should thus be considered a dividing point below which we must view our war readiness with alarm.)

For ease in usage we could well refer to our War Readiness Number as plus or minus W_c. Or some may merely wish to refer to it as our WRN just the same as GNP is used for gross national product.

THE sequence of steps to follow in utilizing the war-readiness formula is:

1. Arrive at a factor value for each of the eighteen factors A through R, either from available statistical information or by estimate.

2. Substitute these eighteen factor values, obtained above, in the war-readiness formula.

3. Solve for W which gives the war-readiness number (WRN).

4. If the WRN obtained in 3 above is below the critical war-readiness number 263 we are seriously deficient and should improve our war readiness.

5. If seven or more of the eighteen factors are each below the critical value for the factor (Column 4, Table 2), then we can expect to be defeated in a war with a major enemy. This will hold true regardless of whether our WRN is above the critical war-readiness number 263.

6. If any one of factors A, B, C, D, E, F, G, H, I, L, M, or N has a value below the disaster value shown in Column 5, Table 2, then we are courting a probable disaster in modern war regardless of whether the conditions of 4 and 5 above are satisfactory.

Month by Month: Highlights of the National Defense

Code of Conduct

President Eisenhower's Code of Conduct for servicemen contains the following six provisions:

1. I am an American fighting man. I serve in the forces which guard my country and our way of life. I am prepared to give my life in their defense.

2. I will never surrender of my own free will. If in command I will never surrender my men while they still have the means to resist.

3. If I am captured I will continue to resist by all means available. I will make every effort to escape and aid others to escape. I will accept neither parole nor special favors from the enemy.

4. If I become a prisoner of war, I will keep faith with my fellow prisoners. I will give no information or take part in any action which might be harmful to my comrades. If I am senior, I will take command. If not, I will obey the lawful orders of those appointed over me and will back them up in every way.

5. When questioned, should I become a prisoner of war, I am bound to give only name, rank, service number, and date of birth. I will evade answering further questions to the utmost of my ability. I will make no oral or written statements disloyal to my country and its allies or harmful to their cause.

6. I will never forget that I am an American fighting man, responsible for my actions and dedicated to the principles which made my country free. I will trust in my God and in the United States of America.

This is an admirable compendium of upright ethical conduct which can be adopted without reservations by all good citizens. It derives from full realization in the heart of every true American that to serve God and country faithfully may demand, in peace and in war, the courage and constancy of martyrs.

General Taylor's Army Credo

Gen. Maxwell D. Taylor, U. S. Army Chief of Staff, recently sent a letter to senior officers of the Army in which he asserted that the Army is not known to the Nation for its true character and worth.

He then enumerated the following eleven concepts which he believes to be true but which are not universally accepted:

1. The Army is the first line of defense of the United States. By its overseas deployments it presents to the enemy the United States soldier as the first obstacle to his aggression and covers the forward bases of the other services.

2. The Army is the versatile and flexible member of the defense team. It does not depend for success on the blind destruction of the "big bang." While developing the use of atomic weapons of great power, it retains the ability to vary the application of military force to the needs of the moment, to make "measured" rather than "mass" retaliation.

3. The Army is a progressive service, looking steadily ahead to the future. While respecting experience and avoiding fads, the Army concerns itself with the next war, not the last one.

4. The Army respects its civilian leadership and abstains from any involvement in politics. It respects the rôle of Congress and responds quickly and accurately to the legitimate requests of members of Congress.

5. The Army is the service which, by the nature of its requirements, attaches greatest importance to human values. It recognizes man as the basic element of military strength. Hence, it works constantly to improve the moral, physical, and intellectual quality of its men. It creates for them an environment of decent clean living, intolerant of vice, dissipation, or flabbiness.

6. In the Army, authority imposes its weight by the professional competence of leaders rather than by the arbitrary or despotic methods of martinets. Second only to accomplishing his mission, the officer's duty is to the welfare of his men. Rank is a badge of responsibility, not a privilege.

7. Because of the essentiality of its mission and the complexities of its tasks the Army must have its share of the best manpower. It offers a worthwhile career for every talent.

8. The Army strives to get the most defense for the money from the resources provided for it. It spends its money prudently for the essentials of defense in accord with good business practices. It is constantly self-critical, trying on its own initiative to uncover inefficiency and malpractice.

9. The active Army is aware of the importance of the civilian components and supports wholeheartedly the programs to strengthen and improve them. It insists, however, on getting a fair return in efficiency and combat readiness.

10. In its interservice relationships, the Army is a loyal member of the national-defense team, resisting encroachments on its own legitimate responsibilities, but scrupulously avoiding trespass on those of the other services. It is open-minded, will listen to reason on any subject, and is opposed to sterile interservice bickering.

11. The Army does not forget its old soldiers after they retire. It remains interested in their welfare and wants them to serve in their civilian communities as loyal, informed representatives of the Army.

An excellent credo, worthy of every support and all admiration!

New Nuclear Reactor

The National Advisory Committee for Aëronautics announced government plans to invest $4,500,000 in a nuclear reactor for the development of an atomic airplane.

A test installation will be established

at Sandusky, Ohio, where research will be carried out on problems of designing and building a nuclear-powered aircraft.

Design of the reactor will probably be completed by the end of the year. Construction contracts will follow.

The Atomic Energy Commission also issued its second invitation to industry for proposals to develop, build, and operate nuclear power reactors with government help.

The invitation, part of the power demonstration reactor program, will be for reactors to demonstrate the practical value of smaller power units for commercial use.

The new invitation is open to individual organizations or groups of organizations representing public or private utilities, equipment manufacturers, or others.

Acceptance of the proposals must meet AEC standards on cost to the Commission, the contribution of the reactor to obtaining competitive nuclear power, and technical and financial competence of those making the proposals.

Atomic Energy Programs

Operation Teapot consisted of a series of fourteen nuclear tests conducted at the Nevada Test Site earlier this year.

This operation introduced a concept of "dual capability," permitting two nuclear devices to be ready for firing on several occasions—one "sensitive" and the other "nonsensitive" in terms of various test criteria, including public safety.

For the first time two nuclear tests were carried out in one day.

The Federal Civil Defense Administration conducted its "Operation Cue" in connection with the thirteenth nuclear test of the series. This was the most comprehensive FCDA exercise ever held in Nevada and consisted of emergency feeding, radiological safety monitoring, and other disaster-related training exercises before and after the detonation.

One nuclear shot in the series and one nonnuclear test were specifically designed to determine the effects of high-altitude atomic detonations required in connection with development of nuclear warheads to be used against attacking enemy aircraft.

In addition to Operation Teapot, a joint Atomic Energy Commission-Department of Defense test ("Operation Wigwam") was conducted in the Eastern Pacific in mid-May.

The principal purpose of the test was to study the effects of a deep underwater detonation. The Commission participated in the test by furnishing the device, assisting in its final assembly and placement, and conducting diagnostic measurements.

As forecast, indications are that the test involved no health hazard to mainland, island inhabitants, or consumers of fish.

Army Budget in Review

Secretary of Defense Charles E. Wilson and Secretary of the Army Wilber M. Brucker recently reviewed the Army's budget for the 1956 fiscal year, seeking to achieve economies that would not affect the Army's combat readiness.

Mr. Brucker emphasized that no effort was made to cut into "the bone and muscle" of the Army. Rather, he said, attention was concentrated on achieving "housekeeping economies."

The Army Secretary declared that the strength of the Army for July 1, 1956, was originally set at 1,027,000 men and that this figure still stood despite rumors that cuts to that total would be made by January 1, 1956.

A cut from the Army's present strength of 1,120,000 men to 1,027,000 in the next few months, Mr. Brucker stated, would cause a "violent disruption."

Mr. Brucker indicated that one way of effecting some of the hoped-for economies might be through a "single service administration" of certain supplies and purchases by the service best equipped to handle the matter. He said the objective would be to avoid overlapping activities that might increase costs.

The indications are that, in accordance with President Eisenhower's assurances, our national defense program will not be weakened by drastic economies.

The public reaction seems to be this: If we must save, let's cut down on overhead. Too much red tape and too much manpower devoted to overhead controls are still areas in the Defense structure where real economies could be effected.

Ordnance Handbook

Your hobby, preoccupation, or annoyance with terminology and nomenclature problems can help an important military project in the field of military engineering.

Ordnance engineering cuts across many fields of science and technology, and information for design work is drawn from many diverse fields of knowledge.

If there is some chance that your subject field might be of interest in ordnance work, and if you have either formal or informal collections of terminologies, glossaries, specialized dictionaries, or even references to them, please contact: Allen Kent, Associate Director, Center for Documentation and Communication Research, School of Library Science, Western Reserve University, Cleveland 6, Ohio.

Several months ago Army Ordnance initiated the preparation of a comprehensive Ordnance Engineering Design Handbook to summarize fundamental principles and basic design data.

The handbook is being written to provide needed information to Army Ordnance and arsenal personnel and to the engineering staffs of contractors having ordnance design responsibilities.

It is planned that the handbook will consist of approximately 180 sections of about 100 pages each. Completion of the first edition of the handbook is expected to require about five years. The format is being worked out so as to facilitate revision of individual sections as may be required by future developments.

Final impetus to prepare the Ordnance Engineering Design Handbook developed during the Korean war when it became evident that availability of a central reference of ordnance design information would have materially speeded up the design, development, and production of new military weapons. In a future conflict, need for such publications may be even more acute.

It is a matter of considerable im-

portance that uncertainties as to the meaning of terminology and nomenclature do not impede ordnance design and development. It is no easy matter to establish definitions for many ordnance terms that are also used in other areas of science and technology.

Coöperation in avoiding confusion as to meanings of terms should prove helpful not only to designers and users of ordnance, but also to you.

Over-all editorial responsibility for the handbook has been assigned to the Ordnance Engineering Handbook Office established by the Office of Ordnance Research at Duke University, Durham, N. C.

The Center for Documentation and Communication Research at Western Reserve University, Cleveland, Ohio, is coöperating with the Engineering Handbook Office in the important areas of terminology definition.

Dry Lubricant Developed

Basic research at the Naval Research Laboratory in surface chemistry—what happens chemically at the surfaces of liquids and solids—has paid off in the development of a "miracle" lubricant with a wide variety of potential military and industrial uses, according to the Navy.

In the form of an easily applied plastic film only a few ten-thousandths of an inch thick, the combination dry lubricant and corrosion preventive is serviceable from 75 degrees below zero to 500 degrees above. Polytetrafluoroethylene, better known in the United States by its trade-name, "Teflon," and previously well established as a protective coating and electrical insulating material, is the substance used.

Following tests at the Naval Research Laboratory of automatic pistols, rifles, ammunition, and similar Ordnance equipment which were coated with thin films of the new lubricant, the Marine Corps has completed extensive field tests of coated infantry weapons. According to the Marine Corps, these tests, which lasted approximately eight months, have established that "the original coating provides satisfactory lubrication for an almost indefinite period following issue."

In addition, the dry lubricating film also proved to be "a suitable preservative for long-term storage of weapons under those conditions which might exist in a storage site" and is "much superior" to the conventional preservative both in corrosion-prevention properties and in maintaining combat readiness of weapons.

This development grew out of NRL research for the Navy's Bureau of Ordnance requirement for all-weather lubricants for aviation ordnance during the Korean war and earlier basic research for the Office of Naval Research on the wettability of Teflon and other plastics. An interim solution to the problem of lubricating automatic aircraft cannon from minus 70 to plus 160 degrees Fahrenheit was supplied to the combat forces in Korea within 90 days through the use of synthetic oils and greases which were the product of previous NRL research.

However, there were continuing problems with aviation ordnance lubricated in a conventional manner with oils, greases, or waxes. Such lubricants pick up and retain dust, dirt, debris, and water.

The major lubrication problem in automatic aircraft cannon was associated with the need for a cartridge-case lubricant which would be retained for a long period of time and yet would not become contaminated.

Faced with these problems, chemists at NRL began investigating dry-film lubricants as a replacement for conventional fluid lubricants. First, a detailed outline was prepared of the desirable characteristics for an ammunition lubricant. A satisfactory lubricant for this purpose should have:

1. A coefficient of friction of 0.1 or less over a temperature range of minus 75 to plus 500 degrees Fahrenheit.
2. Good adhesion to brass and steel over the same temperature range.
3. No softening or melting point over this temperature range.
4. Repellence to both water and dirt.
5. Negligible solubility in any oil or solvent which would be likely to contact it.
6. Ease of application without affecting the cartridge metal.
7. Ability to prevent atmospheric corrosion of brass and steel.
8. Economy in terms of cost of application and adequate availability in time of war.

Out of the fourteen most promising dry-film lubricants investigated, only the one adopted could meet these requirements.

New Aircraft Design

Discovery and experimental development of a new concept of aircraft design leading to very marked performance improvement in the transsonic speed range has been revealed by the National Advisory Committee for Aëronautics. Speed gains of as much as twenty-five per cent have been attained by application of the new concept.

Called the "area rule," the new design principle was developed by Richard T. Whitcomb, 34-year-old scientist at the NACA's Langley Aëronautical Laboratory.

Since then, the area-rule concept, which results in a fuselage shape variously described as "Coke-bottle," "wasp waist," and "Marilyn Monroe," has been applied on two supersonic airplanes unveiled by the military services. They are the Grumman F11F-1 (originally designated F9F-9 by the Navy) and the Air Force Convair F102-A (see photograph on page 534).

In simplest terms, the area rule is a rational way of reducing very greatly the sharp drag rise which occurs at transsonic speeds. Whitcomb's work was begun in 1951 in the first of the NACA's transsonic wind tunnels. His work resulted in recognition, for the first time with experimental proof, that when the drag-rise characteristics of wings, bodies, tail surfaces, and other parts of the airplane were considered as a whole it was possible to develop a design where the total drag was greatly reduced. Whitcomb found that the drag rise was primarily a result of the combined cross-sectional area distributions.

In other words, users of the area rule pinch the fuselage where the wings are attached. In this way cross-section area of the fuselage and the wing together become the same as it would be for the streamlined fuselage only, with optimum drag characteristics in the transsonic speed range.

For Armament Preparedness

A review of the aims and purposes of the American Ordnance Association including the historical background, present objectives, relations with the armed forces, and the continuing need for interest in preparedness

The Executive Committee of the American Ordnance Association at its meeting on September 15, 1955, adopted the following declaration concerning the aims and objectives of the Association. Periodically these goals are reviewed in order that the work of the Association may best conform with the national needs for armament preparedness—on land, in the air, on and under the sea. After thirty-seven years of service to the development, production, and supply of superior ordnance by the Science-Industry-Ordnance Team, the Association reaffirms the singleness of its goal and the determination to keep America strong through armament preparedness.—The Editors.

THE American Ordnance Association began as the Army Ordnance Association in 1919 immediately following the First World War. It was apparent in that war that the relationship between science and industry on the one hand and the Ordnance Department of the Army on the other must be kept in closest liaison in time of peace for the prompt development and production of superior ordnance in time of war.

The men who founded the Association had served in positions of highest ordnance responsibility in the First World War and felt personally obligated to take some steps which would guarantee that American science and industry would have a vehicle and that the Ordnance Department of the Army likewise would have a continuing means of bringing about the closest liaison of the two in time of peace. Thus, they hoped to help reduce the time factor and the cost of adequate ordnance production in time of emergency.

Then was begun the unique relationship between the Association and the Ordnance Department of the Army which continued with increasing vigor throughout the next twenty years of peace and the five subsequent years of war. The initial membership of the Association after its first year was 1,900 individuals. The value of the Association to the Army, to the Ordnance Department, and to its members during its first quarter century, in peace and in war, was expressed in highest terms by the Chiefs of Ordnance, the Chiefs of Staff, and the civilian heads of the Army.

It has been estimated by competent authority that the Association's work for the Ordnance Department of the Army prior to the Second World War was responsible in a major degree for the promptness and speed of armament mobilization incident to that conflict. The expectations and the wisdom of the men who founded the Association were fully demonstrated.

Transition from Army Ordnance Association to American Ordnance Association.—With the advent of the unification of the armed forces in 1947, the question arose as to the advisability of broadening the base and the objectives of the Army Ordnance Association to include the advancement of armament preparedness for the Navy and the Air Force as well as the Army. A nationwide committee was appointed under the chairmanship of Col. Herbert A. Gidney, Pittsburgh, Pa., a vice-president and charter member of the Association, to examine and recommend on this subject.

The committee worked long and arduously on its assigned task. It recommended that the Association broaden its base to include all armament preparedness—the Navy and Air Force—in the same degree and through the same methods it had adopted for the Army. A new constitution was pro-

posed to meet the objectives the Committee recommended.

In January 1948 the membership of the Association by letter ballot approved the recommendations of the Committee on Organization. The name of the Army Ordnance Association was changed to the American Ordnance Association, and the proposed new constitution and by-laws were adopted.

Present objectives as stated in the constitution and by-laws.—The objectives of the American Ordnance Association are set forth in its constitution and by-laws as follows:

Constitution—Article I, Section 2.—"The American Ordnance Association shall be a patriotic, educational, scientific, nonpolitical, and nonprofit-making organization of American citizens dedicated to scientific and industrial preparedness for the common defense as one of our Nation's strongest guaranties of national security and peace."

By-Laws—Paragraph 1.—"In conformity with Section 2 of Article I of its constitution, the aims and purposes of the Association shall be:

"(a) To assist in effecting industrial preparedness on the part of a strong private free-enterprise system as being one of America's strongest guaranties of peace;

"(b) To encourage programs for ordnance research and development, particularly among private, industrial, educational, and research organizations in coöperation with the research agencies of the ordnance organizations of the Department of Defense and to keep available the highly specialized knowledge necessary for arming the manhood of the Nation by stimulating interest in the design and production of ordnance matériel;

"(c) To bring to the attention of the people of our country the necessity for scientific and industrial preparedness and through meetings, conferences, and publications to spread a proper understanding of the need for adequate ordnance and related military preparedness;

"(d) To provide, when required, the services of competent committees to investigate and report upon special ordnance subjects and to encourage programs for the adequate understanding of the procurement, production, and other related phases of national preparedness including those new developments of logistics necessitated by modern military strategy and tactics;

"(e) To encourage adequate military training throughout the Nation and the upbuilding of adequate enlisted and commissioned Reserves;

"(f) To promote mutual understanding and to effect cooperation with American scientists, inventors, engineers, and manufacturers in civil life and the personnel of the armed forces;

"(g) To coöperate with all agencies of the Government in planning the mobilization and utilization of the Nation's scientific and industrial resources for the national security;

"(h) To assist in developing and maintaining efficient personnel, both commissioned and enlisted, for the units required for logistical support of the Army, Navy, and Air Force in the event of an emergency;

"(i) To commemorate the services rendered by the industry of the Nation and by the military personnel and civilian employees of the United States Army, Navy, and Air Force and of American science and industry in the wars in which the United States has been engaged."

Present Implementation of Objectives.—The implementation of the above objectives has evolved over the years to a point where its pattern is well established. The principal operations of the Association are:

1. The publication of ORDNANCE, the Association's bimonthly journal. This magazine, established in 1920, has attained a worldwide reputation. It contains articles of current interest by military and civilian authorities on all phases of armament preparedness. It publishes regularly departments devoted to atomic energy, materials progress, new developments, armament electronics, rockets and guided missiles, recent patents, and book reviews. It also contains regularly a section devoted to armament technology. In future this section will be devoted primarily to nonclassified papers delivered at meetings of the Association's Technical Divisions and Committees.

In a recent survey of former members of the Association who allowed their memberships to lapse, scarcely any were dissatisfied with the magazine as to its content or editorial policies.

2. Supplementing ORDNANCE, the Association also publishes THE COMMON DEFENSE—a monthly Washington newsletter for members—containing current information and opinion on armament preparedness. The Association likewise publishes for the benefit of the members of its Technical Divisions and Committees and of its company members INDUSTRIAL PREPAREDNESS, a bimonthly bulletin devoted to general progress in the field of armament preparedness.

3. National, regional, and local meetings and seminars throughout the year are devoted to the discussion and consideration of armament-preparedness problems. These embrace the annual meetings of the Association, the meetings of the Association's forty-seven local Posts and Chapters, and the open meetings of the ninety Technical Divisions and Committees. The degree of interest in these meetings continues at high level, both on the part of representatives of the armed forces and of science and industry.

4. Geographically, the Association's activities are carried forward by the forty-seven local Posts, headquarters of which are in the principal industrial centers of our country. The organization is fortunate in the caliber of leadership and co-

operation it receives from the officials and members of the Posts.

Judged by the degree of interest which is at its highest in the history of the Association, our Posts, with minor exceptions, indicate the value of the function they perform which, under the constitution, is "to assist regionally and locally in carrying forward the annual programs of the Association."

5. When the Army Ordnance Association became the American Ordnance Association in 1948, steps had been taken to perform a broad new function for the Defense Establishment which had not hitherto been in effect. This was the provision for national Technical Divisions and Committees to advise the Defense Establishment, especially the Ordnance Corps of the Army, the Bureau of Ordnance of the Navy, and the Matériel Command of the Air Force, on engineering problems connected with ordnance armament design and production.

These Divisions and Committees have met with universal and enthusiastic acclaim by the agencies of Government and are performing a voluntary service which is both unique and impressive.

The Technical Divisions and Committees, 90 in number, comprising 1,300 members approximately, are confined strictly to voluntary advisory functions concerning armament production engineering problems. They do not operate in the field of procurement, are not concerned with the placement of contracts, and rigorously adhere to the Association's general policies as a nonpolitical, nonprofit, nonlobbying institution. They do not concern themselves with price, market, or any other aspects of merchandising or trade.

The activities of these Divisions and Committees, new to the Association during the past ten years, are now a major function and, judged by opinion on all sides, are a most valuable service. They do not duplicate the work of any other technical society and adhere precisely to the field of ordnance and other armament.

6. As a result of its conservative financial policies and of its determination to keep membership costs low and membership services high, the Association has attained financial strength to assure its continuation over many years. In this review, financial considerations are not paramount.

Relations with the Army, Navy, and Air Force.—After thirty-seven years of constant coöperation with the defense forces of our country, the Association enjoys today the rare distinction of being accorded the closest relationships in the field of ordnance technology with the Army, Navy, and Air Force and, indeed, the entire Department of Defense. This status is largely due to the caliber of the membership and its loyal and efficient coöperation.

It is an accepted fact throughout the armed services that in its dealings with representatives of the Association the organization has no commercial interests, political affiliations or procurement objectives. Hence there is general acceptance of the fact that the American Ordnance Association is not a trade association.

There is also the realization that the design and production of armament in the United States are not normal industrial undertakings and that a society such as the A.O.A. in peacetime, even more than in war, has the opportunity as well as the obligation of keeping alive the interest of American science and industry in the needs and problems of the Defense Establishment, and also bringing to that Establishment the advisory skills and recommendations of the Association's members. There is also full realization of equality of loyalty on the part of the Association to the Army, Navy, and Air Force.

Continuing need for an American membership society devoted to armament progress.—The United States in this year 1955 is again undergoing a change of public opinion which is indicative of less national emphasis on American armament. The Association has lived through two prior episodes of the same nature but in varying degree. Following the First World War the Army Ordnance Association was the lone voice crying for armament preparedness when the general apathy on the part of the public and of industry permitted our armament potential to dwindle almost to the vanishing point. The experience was repeated after the Second World War.

But the Korean war followed before the damage to the Defense Establishment had descended to the depths it had reached twenty years before. It is fair to assume that public interest in armament preparedness will again decline materially, if not during the present generation, certainly during the next, assuming an era of peace in the immediate future.

TODAY, after thirty-seven years, the American Ordnance Association has its highest peacetime membership, 37,543, including 1,216 companies. The activities of its Posts and Chapters are greater than at any preceding time. The work of its Technical Divisions and Committees is more widespread and continues to receive the broadest coöperation from industry members. The Association's publications are at their peak in number of pages and in circulation.

Apparently the objectives of the Association are being met more successfully than ever before, and it is proposed that in the light of this survey the aims and purposes of the Association as set forth in its constitution and the methods of implementation described as above continue without interruption and with vigor.

To the question: Shall the Association change direction in any respect? The answer, sustained by experience of more than thirty-seven years, is: Hold course and full steam ahead!

ASSOCIATION AFFAIRS

Executive Committee of the A.O.A. Holds Meeting in Washington, D. C.

The Executive Committee of the Association's Board of Directors met at A.O.A. headquarters, Washington, D. C., on Thursday, September 15th.

Vice Adm. George F. Hussey, Jr., president of the Association, presided at the meeting attended by Lieut. Gen. Levin H. Campbell, Jr., Washington, director; Harvey C. Knowles, Cincinnati, vice-president; Louis Polk, Dayton, vice-president; R. E. Gillmor, New York, director; John F. Floberg, Washington, assistant counsel; Florence G. Ferriter, Washington, secretary; and Leo A Codd, Washington, executive vice-president.

A memorial resolution for Col. Charles Deere Wiman, late director and a founding member of the A.O.A., was read by General Campbell and a memorial resolution in tribute to Mrs. William Crozier, only woman charter life member of the Association, was read by Colonel Codd. Both resolutions were unanimously adopted.

Colonel Codd presented a report on the status of the finances and membership of the Association and furnished each member with detailed tabulations for the past eight months. At the recommendation of Admiral Hussey, Maj. Gen. James D. McIntyre, treasurer of the Association, was elected to serve as a director for the unexpired term of Colonel Wiman to December 31, 1956. The Admiral then introduced a staff study, prepared at national headquarters, that reviewed the aims and purposes of the A.O.A. After general discussion, the recommendations of the study were unanimously approved. (The study is published in full on pages 438-440 of this issue.)

Pertinent parts of the last will and testament of Mrs. Crozier were read by Colonel Codd. Mrs. Crozier has named the Association as the beneficiary to receive her residence and a bequest of $25,000 for the provision of a library. It was resolved that the Association accept Mrs. Crozier's bequests, and a committee was appointed to study the details in connection with eventual disposition of the property.

Admiral Hussey's recommendation to appoint a special board to report to the membership on the function of the Ordnance arsenals in keeping alive the ordnance art in time of peace was unanimously approved.

The president, with the committee's approval, appointed the following nominating committee: Ralph L. Goetzenberger, Washington, D. C.; Col. Herbert R. White, Detroit, Mich.; and William A. Wilson, Los Angeles, Calif. They will present at the next Board meeting their nominations for five directors for terms of four years and twenty-four members at large of Council for terms of one year beginning January 1, 1956.

The Committee then adjourned and proceeded to the Hotel Mayflower to greet the members of the Army, Navy, and Air Force Liaison Committees who were their luncheon guests. The names and photographs of the members of these committees are published on pages 428-429.

After the luncheon Admiral Hussey spoke briefly in praise of the splendid cooperation between the services and the Association that has been emphasized by the establishment of the Liaison Committees.

• **AT SAN FRANCISCO.**—The board of directors of the Post met at the Pacific Union Club for luncheon on September 1, 1955. Lawrence S. Fletcher, Post president, as presiding officer presented the A.O.A Certificate of Appreciation to G. M. Greenwood, Rheem Manufacturing Company, past Post president, and introduced Col. Calvin A. Heath, the new secretary-treasurer of the Post.

L. S. Fletcher, left, San Francisco Post president, presents certificate to G. W. Greenwood, past president, while Col. C. A. Heath, right, watches proceedings.

Colonel Heath has assumed command of the San Francisco Ordnance District, relieving Col. John M. Stark. Colonel Heath gave the directors a résumé of his service background and his experience in the Detroit Ordnance District.

OVER 400 MEMBERS AND GUESTS ATTEND ANNUAL GOLF TOURNEY AND DINNER SPONSORED BY THE WASHINGTON POST

With complete disregard for overcast and rainy weather, over 220 enthusiastic golfers entered the annual competition sponsored by the Washington Post for the Ben Fairless and McCaffrey Trophies at the Army-Navy Country Club on Thursday, September 22nd. The Fairless Trophy, from U. S. Steel Corporation, for low net was won by Ralph E. Pies of the Navy Bureau of Ordnance, and there was a tie for the McCaffrey Trophy, presented by International Harvester, between Franklin B. Reybold, Alco Industries, and W. F. Reynolds, Calcium Chloride Institute. In a sporting toss, "Brick" Reybold was awarded the cup.

At the reception and dinner more members joined the golfers to swell the crowd to over 400. Dinner was served informally without speeches or other fanfare preceding the assembly of all hands in the ballroom for presentation of golf and horseshoe pitching awards and the drawing for door prizes.

In addition to silver cups, Messrs. Pies, Reybold, and Reynolds received handsome awards in the form of golf equipment and radios. Many other contestants were presented with prizes for such outstanding feats as hole-in-one, the maximum number of fives, sixes, and eights, and blind bogey.

Through the generosity of a large number of industrialists represented in the Washington Post, there was a tremendous assortment of prizes for the holders of

Maj. Gen. Emerson L. Cummings, Chief of Army Ordnance, second from left, felicitates Col. William J. Rushton as he retires as civilian chief of the Birmingham Ordnance District while Col. H. G. Lang, district commanding officer, left, and G. S. Lawson, new chief of the Birmingham district, right, look on.

the lucky registration numbers. At the final drawing in which all hands participated, two television sets presented by Crosley and Bendix and a Frigidaire presented by H. L. Jennings of General Motors were the choice pieces.

The winner of the Frigidaire was Capt. James F. Byrne, commanding officer, U. S. Naval Proving Ground, Dahlgren, Va. The skipper was just going out the front door to drive back to his station when he heard his number called to receive the prize.

This gala occasion required strenuous efforts on the part of many members of the Washington Post and particular thanks are due to the president, George M. Riveire, Goodyear Tire & Rubber Company; A. E. Decker, Allis-Chalmers, general chairman; John Tope, Republic Steel, program chairman; S. L. Magee, United States Steel, invitations and announcements; R. W. Berry, Avco Corporation, golf committee; James G. Clark, Bureau of Ordnance, horseshoe pitching committee; Kenneth Hampton, Detroit Diesel Engine Division of General Motors, door prizes; Capt. Charles S. Wiggins, Borg-Warner Corporation, dinner committee; Raymond E. Williams, American Motors Corporation, membership committee.

Western Michigan Chapter Meets for Luncheon and Military Demonstration

The many loyal members of the American Ordnance Association from Grand Rapids, Kalamazoo, Muskegon, and other cities of Western Michigan assembled with the local Ordnance fraternity at St. Joseph, Mich., on September 9th. A record crowd of over 250 members and guests were on hand at the Hotel Whitcomb where they were joined by contingents from the Lansing Chapter and the parent Post at Detroit.

The guest of honor at the luncheon meeting was Brig. Gen. J. B. Medaris, chief of the Industrial Division, Office of the Chief of Army Ordnance. Elisha Gray, II, Chapter president, greeted the guests and turned over the meeting to the toastmaster Don M. Compton, civilian adviser to the commanding general, Fifth Army.

Mr. Compton introduced guests at the speakers' table including Assistant Secretary of the Army George Roderick; Maj. Gen. P. D. Ginder, commanding general, Fifth Army; Maj. Gen. George Moran, Michigan National Guard; Brig. Gen. P. M. Seleen, commanding general, Ordnance Tank-Automotive Command; B. L. Gordon, Blackmer Pump Company, Grand Rapids; S. K. Harrington, Kalamazoo; Paul Moore, Lear, Inc., Grand Rapids; G. B. Bonfield, American Box Board Company, Filer City; and Roger Waindle, a long-time businessman of Western Michigan who had come all the way from Boston, Mass., to attend this meeting.

General Medaris spoke on the mission of Army Ordnance in developing weapons of the future, building his talk for the most part around guided-missile development. He made it plain that Army Ordnance was exploring fields of science that might aid in producing more advanced weapons and did not consider that guided missiles were necessarily the final answer. The General stressed that science has had to advance in great strides over the past ten years in order to attain the present status and that, although Ordnance held the responsibility for weapons, it needed the full support of industry both in research and production in order to ensure the supremacy of our weapons in the future.

Following luncheon the Chapter embarked in gaily decorated automobiles and buses to reassemble at the Twin Cities Airport. Here units of the Michigan National Guard, including the 246th Tank Battalion, the Headquarters Company, 46th Infantry Division, and the 172nd Fighter-Interceptor Squadron demonstrated in a simulated air-ground maneuver against an aggressor unit the high standard of training of the Guard in Western Michigan. At the conclusion of the sham battle an Army rescue helicop-

Elisha Gray, II, president of the Western Michigan Chapter, left, and Britton L. Gordon, Chapter secretary, right, welcome Maj. Gen. J. B. Medaris, chief of the Industrial Division, Office of the Chief of Ordnance, the guest of honor.

ter alighted to remove two of the simulated wounded.

After this stirring demonstration some members stayed to view exhibits of guided missiles, guns, tanks, and combat vehicles while others returned to St. Joseph for an interesting tour of the Whirlpool Corporation plant.

It was truly an outstanding event in the annals of the Michigan Post, well conceived to impress industry with the importance of armament preparedness.

Rio Grande Post Marks Transfer of Headquarters to White Sands, N. Mex.

Brig. Gen. Thomas K. Vincent, A.O.A. staff consultant for Technical Divisions and Committees, left, addresses meeting of the Rio Grande Post. Others on the speakers' platform are, left to right: M. S. Darbyshire, member, executive committee; Capt. J. M. P. Wright, A.O.A. consultant for Posts; Col. H. E. Minton, retiring Post president; Brig. Gen. L. I. Davis, USAF, new vice-president.

The Rio Grande Post commemorated the transfer of Post headquarters from El Paso to White Sands Proving Ground, N. Mex., at an all-day meeting on Wednesday, July 27th, that included the installation of recently elected officers and directors.

Members arrived from as far as Deming and Roswell, N. Mex., to join the crowd from El Paso as the meeting opened at the proving ground auditorium at 10 a.m.

This was an auspicious occasion at Rio Grande for not only was a new headquarters established but new officers and a greatly increased board of directors were installed, while membership had been almost tripled in the preceding two months.

Brig. Gen. W. L. Bell, commanding general, White Sands Proving Ground, greeted the assembly and introduced Col. Henry E. Minton, retiring Post president. Colonel Minton described the origin of the Post, heartily acclaimed the shift of Post headquarters, and asked Capt. J. M. P. Wright from national headquarters to introduce the new officers and directors.

After the introductions Captain Wright read the preamble to the A.O.A. constitution and expressed the appreciation of the entire Association for the interest and support of the Rio Grande Post before turning over the chair to the new president, General Bell.

Brig. Gen. Thomas K. Vincent, former commander of Redstone Arsenal and now staff consultant for Technical Divisions and Committees of the A.O.A., was the principal speaker. The general emphasized the necessity of close cooperation between civilian industry and the ordnance activities of the armed forces. He pointed out that one key to this cooperation was the Technical Division organization of the Ordnance Association.

General Vincent enumerated the various Technical Divisions and Committees the A.O.A. has established and noted that it was the responsibility of these groups to keep abreast of new manufacturing processes in order to give prompt assistance in solving the engineering and production problems of ordnance.

General Bell announced the committee memberships and outlined the Post's program under the guidance of his committees for program planning, membership, and publicity. Following the business meeting all hands were treated to a showing of a color film on operations at White Sands and then adjourned to the Rocket Club for luncheon.

After the luncheon a cavalcade of buses and automobiles carried the members to one of the numerous launching sites where Col. B. J. L. Hirshorn gave a briefing on General Bell's dual mission of operating an integrated testing range for all three services and directing the missile proving for Army Ordnance. Lieut. Col. J. F. Peters next explained the unclassified features of the Nike antiaircraft missile and the programming for the test shot. Although the missile was soon lost in some light clouds after firing, the test appeared satisfactory. The members also inspected the original underground Nike launching equipment and were briefed on the Honest John rocket.

In the assembly area the proving ground personnel had lined up the vehicles and equipment that gave the necessary mobility to firing Honest John and the Corporal missile. Demonstrations were given

Members and guests of the Yankee Post of the Association are shown inspecting various marine units during a visit to the Boston Naval Shipyard.

of positioning and fueling techniques of both weapons.

The Association is sincerely grateful to General Bell not only for his hospitality but for devoting his valuable time in cooperation with Colonel Minton of El Paso in stimulating interest in the Post. The entire effort was implemented by the excellent work of the new Post secretary, Lieut. Col. J. M. Hamblin.

The new officers in addition to those mentioned are: Vice-presidents, Brig. Gen. L. I. Davis, H. M. Dow, C. A. Lindeman, and Herbert L. Karsh; treasurer, Capt. W. H. Clark.

The new directors are: General Bell, Brig. Gen. J. M. Reynolds, Col. Sylvester A. Hall, M. S. Darbyshire, Harry James, Henry H. Bruhn, C.W.O. John F. Carson, Guy L. Rogers, G. W. Rogers, General Davis, Capt. Levering Smith, U.S.N., Colonel Minton, J. A. Bonnell, Rupert Chisholm, R. J. Hodson, Frank M. Bowman, Robert B. Smith, and A. H. Ribble.

New Orleans Chapter Members See Aërial Demonstration at Eglin AFB

Seventy members of the New Orleans Chapter of the American Ordnance Association motored to Eglin Air Force Base, Fla., where they witnessed an aërial firepower demonstration presented by the Air Proving Ground Command. Following the demonstration the members were the special guests of the commander of the Air Force Armament Center, Maj. Gen. Edward P. Mechling.

Maj. Gen. E. P. Mechling, Commander, Air Force Armament Center, left; Col. P. S. Bechtel, president, Florida Post, center; and W. L. Love, president of the New Orleans Chapter, right, discuss program at Eglin Air Force Base.

Among the distinguished guests were Robert Swezey, executive vice-president of the WDSU Broadcasting Company; Mel Leavitt, special events director at WDSU-TV; and Willard Love, production engineer, Rheem Manufacturing Company, and president of the New Orleans Chapter of the Association.

The group arrived at Eglin Field in time to view a thrilling exhibition of precision acrobatic flying presented by the Sabre-Knights, a group of four officers of the Air Defense Command who are stationed at Castle Air Force Base, Calif.

There followed an action-packed demonstration of Air Force firepower which included gunnery—air-to-air and air-to-ground; bombing from all altitudes from fifty feet up; rocketry; a demonstration of an air evacuation of a downed airman; and a fly-by of the famed Boeing B-52.

A comparative bombing display was highlighted by a flight of a B-17, the World War II stand-by, and a B-36, the long-range intercontinental bomber.

At the conclusion of the demonstration and after lunch at the Officers' Club, the A.O.A. group visited the ground gunnery range of the Air Force Armament Center at Eglin. The Air Force Armament Center, one of the ten centers of the Air Research and Development Command, presented an air armament display which illustrated its mission of research and development testing of Air Force Armament.

Lieut. Col. Jack Whittset, assistant director of test operations of the Armament Center and narrator during the demonstration, pointed out the requirements for developmental testing of air armament in order to produce at the proper time the armament subsystem to fit the complete Air Force weapon systems requirement.

After the weapons demonstration Mr. Love and other A.O.A. members met informally with General Mechling and were briefed on some of the current trends and solutions to the air-armament problems which face the defense effort of the country. An interested member of this group was Col. Paul S. Bechtel, chief of the Plans and Programs Division, AFAC, and president of the Florida Post of the Association. Mr. Love and Colonel Bechtel discussed the plans and activities of their respective Posts.

The group motored back to New Orleans with a fuller understanding of Air Marshall Lord Trenchard's statement—"Without armament there is no air force."

• **AT ALBUQUERQUE.**—The Albuquerque Chapter of the Rocky Mountain Post met on September 5th at the auditorium of the University of New Mexico. Col. Charles F. H. Begg, Chapter president introduced the guest of honor, John R. Townsend, director of materials and standards engineering at the Sandia Corporation.

Mr. Townsend, who has been chairman of the Standards Council of the American Standards Association, gave the members an excellent account that explained how vital standardization has become in the progress and growth of industry.

• **AT ABERDEEN PROVING GROUND.**—American Ordnance Association awards recently were presented to the outstanding cadets of the 1955 R.O.T.C. summer camp. Maj. Gen. E. L. Cummings, Chief of Army Ordnance, took the review and after a brief address presented commissions to all the student officers.

Following General Cummings, Brig. Gen. T. K. Vincent, staff consultant of the American Ordnance Association for Technical Divisions, spoke to the students and presented the Association's medal award to the outstanding cadet in the regiment and in each company and battalion. General Vincent gave the newly commissioned officers some down-to-earth advice on achieving a successful career in Ordnance. He stressed particularly that in addition to observing the usual military customs it was important that they put their shoulder to the wheel technically yet without attempting to change practices of long standing that might at first seem to be questionable.

The following honor cadets received the American Ordnance Association's bronze medal and lapel bar: Richard L. Tapp, John T. Hayes, and William H. Rudnick, The Citadel; William A. Leitner, Clemson Agricultural College; David L. Ellis, Marshall College; John E. Lancaster, Georgia Institute of Technology; and Maurice M. Patterson, Rice Institute.

Cleveland Post Conducts Industrial Preparedness Tour at Goodyear Plant

The Third Annual Industrial Preparedness tour of the Cleveland Post surveyed the Goodyear Aircraft Corporation on September 22nd. Attendance was 270 for the all-day visitation.

Welcoming Post members were Edwin J. Thomas, president of Goodyear Tire and Rubber Company, a Post director; T. A. Knowles, vice-president and general manager, Goodyear Aircraft Corporation; A. J. Weatherhead, Jr., president of the Weatherhead Company, Cleveland, and Post president; and J. E. Trainer, executive vice-president of Firestone Tire & Rubber Company, a national director of the A.O.A. and the Post's vice-president and activities chairman. Goodyear Aircraft played host at a luncheon served in the flight hangar.

The spectators viewed airframe and plastic manufacturing divisions; viewed the Nike booster case plant; saw aircraft wheel and brake assemblies; studied radar detection structures; learned something of lighter-than-airship fabrication in Goodyear's huge aircraft dock, one of the world's largest structures; and "sailed" through the U. S. Naval Air Station located adjacent to the Goodyear plant.

Through the offices of the Cleveland Ordnance District, a complete Nike launcher unit was brought to Akron and placed on display. An Air Force Matador, B-61B missile, today's latest "buzz bomb," also was exhibited.

Concluding the day's program was a flying salute by a Goodyear blimp and maneuvers by the Naval Air Station Drill Team, one of the crack units of its kind in the country.

Shown inspecting a Nike missile unit at the Cleveland Post meeting are, left to right: J. E. Trainer, Post vice-president; Col. J. G. Duncan, chief, Cleveland Ordnance District; Comdr. A. E. Gillogly, Navy Bureau of Aëronautics; E. J. Thomas, Post director; and A. J. Weatherhead, Jr., Post president.

Maj. Gen. E. L. Cummings, right, Chief of Ordnance, accepts Volume I of Ordnance Department World War II history from Col. John Meade, Acting Chief of Military History, and Dr. Harry C. Thomson, chief of the Ordnance Historical Branch.

• **MAJ. GEN. WILLIAM H. TSCHAPPAT,** former Chief of Army Ordnance and a life member of the American Ordnance Association, died at Walter Reed Hospital, Washington, D. C. September 22, 1955.

General Tschappat was recognized as an international authority in the science of ballistics and a leader in the development and improvement of artillery, particularly antiaircraft guns. His influence in artillery design is evident in many of today's modern weapons.

Upon his graduation from West Point in 1896 he became a second lieutenant of artillery, later joining the Ordnance Corps. Throughout his long career he served at many Army arsenals and as inspector of ordnance at manufacturing plants. During World War I he was Ordnance Officer at the Port of Embarkation at Newport News, Va., and thereafter he commanded Aberdeen Proving Ground where he directed many improvements in ordnance design and ballistic determinations. He was Chief of Army Ordnance from 1934 until his retirement, August 31, 1938.

General Tschappat was acknowledged to be one of the foremost mathematicians and ballisticians in the history of Ordnance in the United States. While professor of ordnance at the United States Military Academy, West Point, he was the author of "Ordnance and Gunnery," the standard textbook used at the Academy for many years.

His prowess as a mathematician was instrumental in solving many of the most complex engineering problems which faced the Ordnance Department during a transition period when the strength of metals, range of weapons, and striking power of missiles were undergoing basic advancements. His kindly, quiet manner of engineering application and administration befitted his intellectual genius.

At funeral services which were held at the United States Military Academy, Tuesday, September 27th, with full military honors, Maj. Gen. Emerson L. Cummings, Chief of Ordnance of the Army, and instructors in the Department of Ordnance at the Academy were among the honorary pallbearers. Representing the officers who served under General Tschappat during his long Ordnance career was Brig. Gen. Norman F. Ramsey, U.S.A., retired, former commanding general at Picatinny Arsenal and later at Rock Island Arsenal. Col. Leo A. Codd, executive vice-president, American Ordnance Association, represented the Association's officers and directors.

• **COL. HERBERT G. STANTON,** former superintendent of Stanton Prepar-

atory School, Cornwall, N. Y., died at his home in Cornwall-on-Hudson, September 15, 1955.

Colonel Stanton graduated from West Point in 1911, serving in World War I in the rank of lieutenant colonel. He resigned from the Army in 1925 to organize the Stanton School.

During World War II, Colonel Stanton was assigned to active duty to serve as executive officer of the Army Proving Ground at Edgewood Arsenal for which he was awarded the Legion of Merit. In the latter part of the war he was commanding officer of the Ordnance Training Center, Camp Perry, Ohio.

• **MAJ. GEN. MERRITT A. EDSON,** commander of "Edson's Raiders" of Marine Corps fame during the fighting in the Solomon Islands in World War II and executive director of the National Rifle Association, died at his home in Washington, D. C., on August 14, 1955.

He retired from the Marine Corps in 1947 after thirty years of distinguished service during which he was awarded the Medal of Honor for his defense of Henderson Field on Guadalcanal, the Navy Cross for heroism in Nicaragua in 1928-1929, a second Navy Cross at the assault on Tulagi in the Solomons, and the Silver Star as chief of staff of the Second Marine Division at the invasion of Tarawa.

General Edson's career covered a wide field of experience. He was commissioned in 1917 and served in France in World War I. In 1922 he qualified at Pensacola as a naval aviator and was on flying duty in Guam in 1923. As a captain he first acquired skill in unorthodox jungle warfare as commander of one of the Marine units in Nicaragua in 1927.

Here he won fame in military circles for his skillful use of men and weapons in the Coco River area. The 60-man column he commanded established a record of performance for a unit of its size that was acclaimed to be the most effective of its day.

In 1923 in recognition of his expert knowledge of weapons the Navy assigned Edson, then a junior lieutenant colonel, to the Navy's equipment testing board.

General Edson was a true professional soldier, a hard fighter, and shrewd planner who led the "Raiders" that he organized and trained with skill and daring in early Pacific campaigns and then helped plan assaults on Iwo Jima, Okinawa, and other islands while serving on the Fleet Marine Force staff.

General Edson was a native of Vermont and prior to becoming executive director of the National Rifle Association was head of the Vermont State Police. In addition to his great leadership of the NRA he maintained an interest in all ordnance matters through his membership in the American Ordnance Association.

• **GEORGE B. McC. TROXELL,** manager of carbon bar sales, Bethlehem Steel Company, and a life member of the American Ordnance Association, died at St. Luke's Hospital, Bethlehem, Pa. on Thursday, August 11, 1955.

After graduation from Purdue University in 1916 he went to work for the Bethlehem Steel Company where he was employed in many capacities, becoming carbon bar salesman in 1929. During World War II he was manager of ordnance for the company and in 1946 was appointed to the position he held recently.

In addition to life membership in the Association he was a member of both the American and British Iron and Steel Institutes and the Newcomen Society. For his outstanding coöperation with the armed forces during World War II he received the Army Steering Committee award from the Bureau of Ordnance and the Metallurgical Advisory Board award from Army Ordnance.

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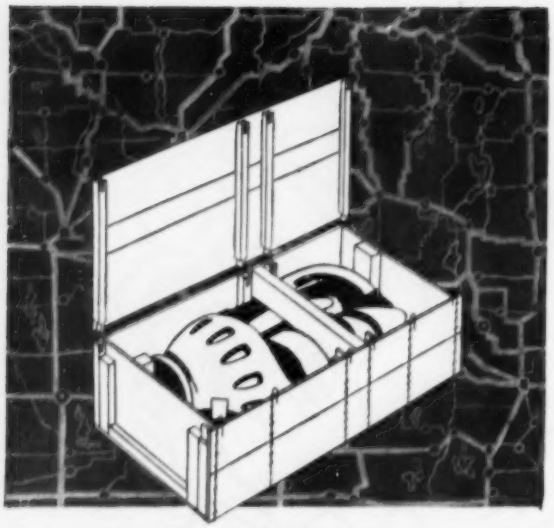

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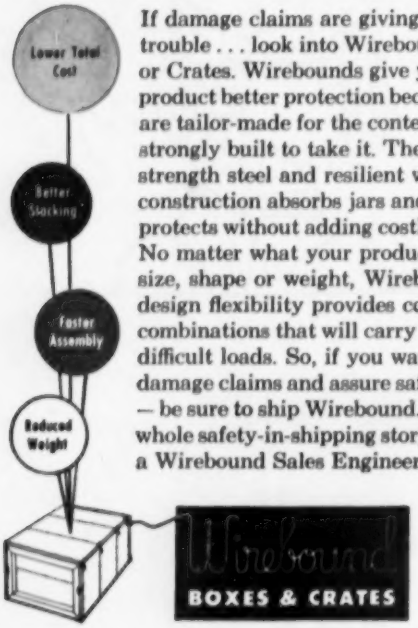

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A.O.A. Artillery Division Meets at Rock Island Arsenal

The Artillery Division of the Association met at the Rock Island Arsenal on September 23, 1955, under the chairmanship of J. E. Trainer, Firestone Tire & Rubber Company, Akron, Ohio.

Sixty-one members and guests were present, including twenty industry representatives, six advisory members, nineteen from Rock Island Arsenal, and sixteen from the Headquarters, Ordnance Weapons Command.

The meeting was opened by Col. A. R. Cyr, Ordnance Corps, commanding officer of Rock Island Arsenal. He paid tribute to the American Ordnance Association and its contribution to maintaining the "level of preparedness."

Brig. Gen. T. K. Vincent, from A.O.A. headquarters, brought greetings from the national officers of the Association and pointed out that the three services were participating in this meeting which was in accord with the 3-service make-up of the American Ordnance Association.

Mr. Trainer, in discussing the operation of the Division, stated that it was not organized to make a job if one was not there in reality. Its position was one of "readiness to serve"—to be organized for use when called upon. The annual meeting was for the purpose of getting reacquainted with each other and for being brought up to date on artillery advances and forecasts by the service representatives who would present papers. As Mr. Trainer expressed it, when industry and the services know each other well, problems disappear.

Brig. Gen. T. A. Weyher, commanding general, Ordnance Weapons Command, covered the "Functions of the Weapons Command and Its Relationship to Industry." The Office of the Deputy Chief of Staff for Logistics (DEPLOG) which has command responsibilities for the technical services and which controls men, money, and materials, is a changed concept in organization, he said. The problems of industrial mobilization, the lay-away plan for conserving production equipment, and the difficulties of producing from research and development drawings were discussed.

The unbalance of field-service stocks and the use of surplus field-service stocks of spare parts to make major items was one of the conservation of materials operations being carried out. An interesting figure was given—that the ownership costs of spare parts equal twenty per cent of the inventory value annually. General Weyher emphasized that the district-contractor relationships were not affected by the weapons command concept.

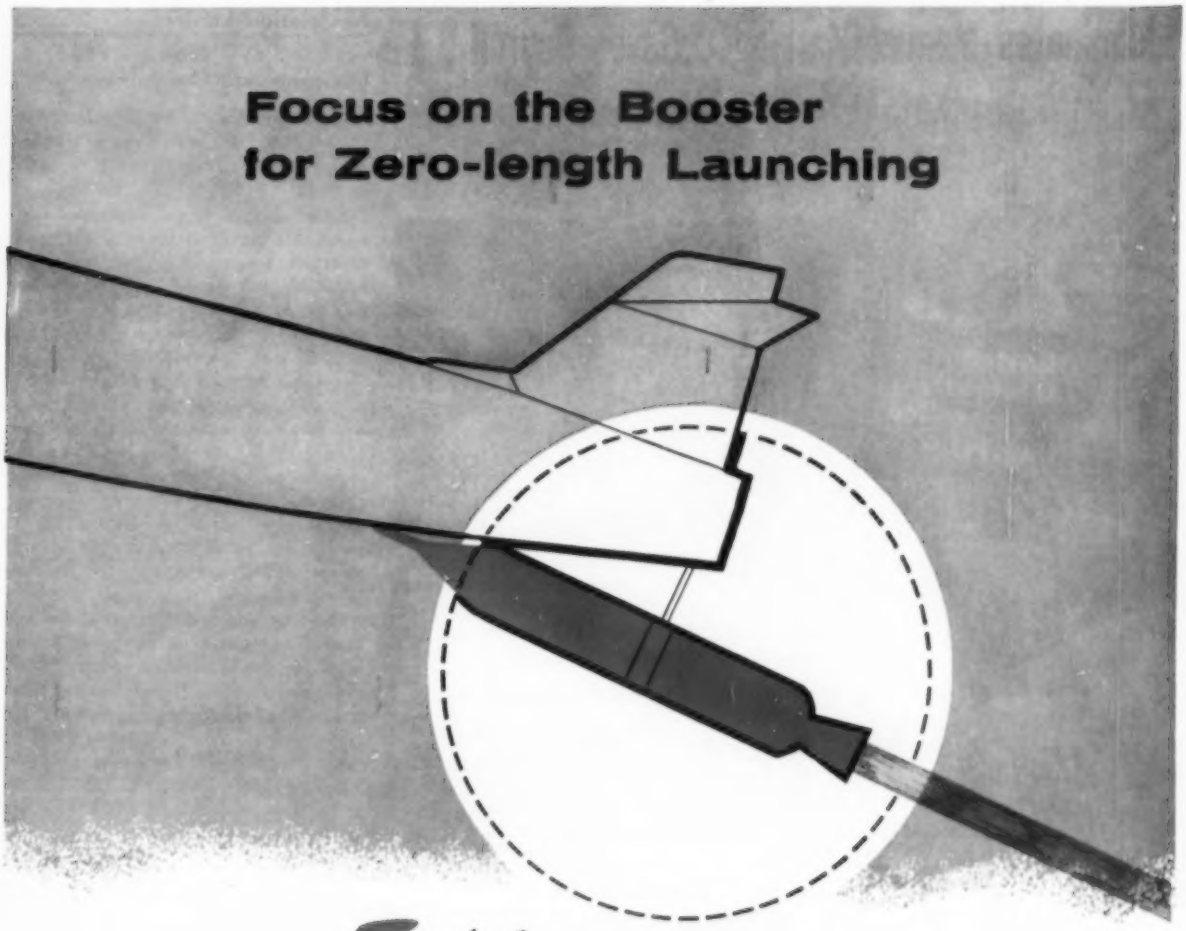
Col. P. J. Roberts, Ordnance Corps, chief, National Production Equipment Office, known as "Pequo," discussed the operations of his office. This is concerned with the recording and storing of real production equipment, not just a paper operation. Colonel Roberts' assistants discussed the principal phases of the Pequo operation.

Col. Samuel Smellow, chief of the Artillery Development Branch, Research and Development Division, Office, Chief of Ordnance, discussed "The New Look in Artillery Weapons," covering the old-fashioned towed artillery versus guided missiles and new weapons. There is a considerable field and need for towed artillery, and it must be designed so as to include the advances in the art. Weapons systems, not just the weapon alone, with electronic gear must be considered.

N. S. Glassman, chief of the Carriage and Recoil Mechanism Section, Artillery Development Branch, Ordnance Research and Development Division, discussed further the new look in towed artillery.

Comdr. A. R. Brueggemann, chief of gun mount and missile launcher developments, Navy Bureau of Ordnance, covered "Developments in Naval Gun Mounts and Missile Launchers." His

Focus on the Booster for Zero-length Launching



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Divisions and Committees

talk was enlightening to all present and by means of slides and movies he clarified many things in connection with naval weapons.

After luncheon it was announced with regret that the Hon. Frank H. Higgins, Assistant Secretary of the Army for Logistics, was detained in Washington and would not be present. Mr. Trainer then gave a very timely and inspiring talk in which he strongly urged that everything be done to maintain the dignity and prestige of the officer corps of the services so that the trained and skilled officers of the three services, who are essential to the continuity of the defense programs, will have a real incentive to continue on active duty. This is particularly noteworthy at this time of unrest and uncertainty in the commissioned ranks.

He also emphasized the need for our arsenals to maintain the nucleus of "know-how" for use in assisting industry when expansion in time of need requires them to go into armament manufacture. He stated that he knew of no other way in which to stockpile know-how and that this was most essential.

The tour of the arsenal was most instructive. The production shops were visited and the 106-mm. BAT weapon, the Honest John rocket launcher, and overhaul techniques for the "Pequo" machine-tool program were examined. A trip to the proving ground completed the tour, and the powder-type recoil mechanism gymnasticator was observed in operation. This simulates actual firing conditions without the attendant cost or danger and enables recoil mechanisms to be tested quickly and safely.

The water projectile method for proof firing a gun, recoil mechanism, and carriage as a unit, without requiring special range facilities or using metal projectiles, is an ideal way to proof fire in an inhabited area. This was developed at Rock Island Arsenal and shows great promise.

In the evening an excellent refreshment hour and buffet dinner was enjoyed by the members and guests from the Weapons Command and Rock Island Arsenal and their wives. Mr. Trainer was the host, and this get-together served to complete a very interesting meeting.

FIRE CONTROL COMMITTEE OF UNDERWATER ORDNANCE DIVISION MEETS AT SUB BASE, NEW LONDON, CONN.

The Fire Control Committee of the Underwater Ordnance Division met at the Submarine Base, New London, Conn.,

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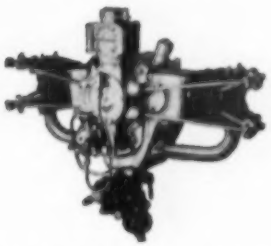

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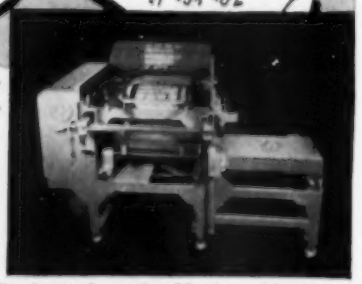

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Association Affairs

Divisions and Committees

on July 7 and 8, 1955. Lewis W. Imm, chairman of the Committee, presided, and A. L. Coulson acted as secretary.

The afternoon of July 7th was spent aboard the U.S.S. TROUT and the U.S.S. HARDER for torpedo firing exercises. Excellent presentations concerning the fire-control equipment aboard these vessels were given by the officers and men.

On July 8th the morning was spent in a presentation of submarine fire-control equipment by Base personnel. A tour of the Submarine School and the Attack Theater completed this session. A business meeting was held after luncheon.

METAL WORKING LUBRICANTS COMMITTEE OF ADVISORY TECHNICAL AND RESEARCH GROUP MEETS AT COLUMBUS

The Metal Working Lubricants Committee of the A.O.A. Advisory Technical and Research Group met at Lockbourne Air Force Base, Columbus, Ohio.

The meeting was opened at 9 a.m. by Chairman W. J. Reitze, Esso Standard Oil Company. Col. H. A. McDaniel, U.S.A.F., commander of Lockbourne Air Force Base, welcomed the group.

Brig. Gen. T. K. Vincent, from A.O.A. national headquarters, discussed the functions of the Association and stressed the technical work carried on by the Committee.

Following the introduction of all those present, George Robinson of the Chemistry and Physics Division, Franklin Institute, Philadelphia, Pa., described the functions of the institute as a quasipublic organization doing research by contract.

S. N. Muchnick, also of Franklin Institute, discussed the study of surface films. The importance of absorbed films in connection with bonding strengths and lubrication were described. Surface preparation is very important in operations such as heavy-duty presswork, since failure between surfaces is in the oxide film and not in the metals.

Marco Petronio, Frankford Arsenal, covered the subject of lubrication in the cupping and drawing of titanium in considerable detail. He showed specimens illustrating the importance of proper lubrication and speed of draw.

In cutting titanium a similarity between it and stainless steel was mentioned. In one case titanium was found to cut best when dry, but anodizing may be beneficial. In barrel drilling, cutting is performed at considerably slower speeds than with steel, but there is much difficulty because of chipped formations. Sulfurized or chlorinated materials were found to be more effective after surface treatment. (*Continued on p. 454*)

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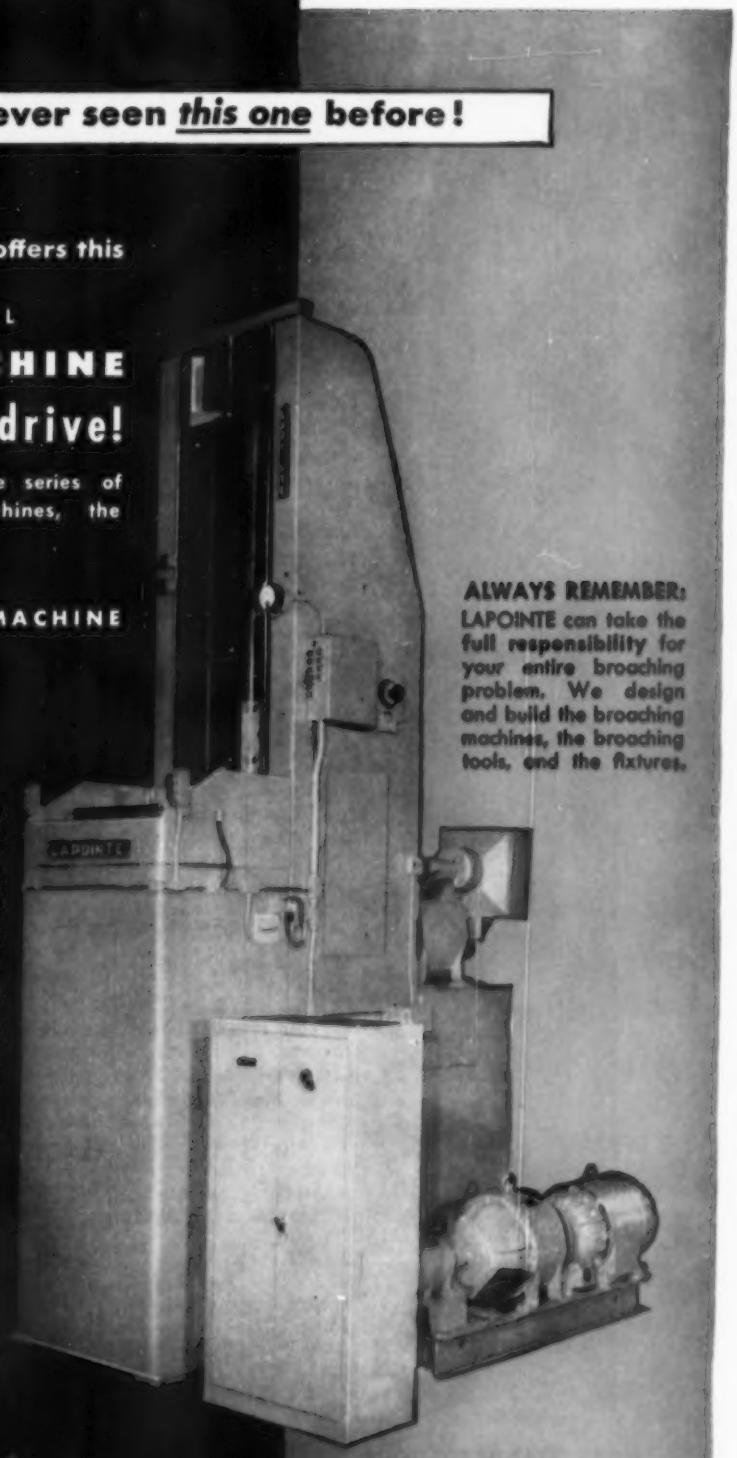

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Divisions and Committees

In machining titanium, the friction between chip and tool is said to be low, but difficulty is due to the high temperature at the tool face. Bonding and high friction cause difficulty in grinding.

In drawing, the nature of the surface is more important than roughness. Voids in the surface are not as important as getting the lubricant actually to adhere to it. A heavy surface preparation will allow up to four draws between treatments.

The dimpling problem, assigned to Melville Yancey of Olmsted Air Force Base, has been solved successfully. A wax emulsion was found to perform well and could be removed by water washing. The coupling agents and water in ordinary soluble oils may not be successful at the temperatures of this operation, although soap and oil mixtures probably would be satisfactory and would have the same washing properties as the wax.

Capt. Paul J. Wolf, Wright-Patterson Air Force Base, outlined the development of heavy presses by the Air Matériel Command and described the forging and extrusion presses now in existence. He introduced H. L. Shaw, of Battelle Memorial Institute, who described the heavy-press research work being done under contract for the Air Matériel Command.

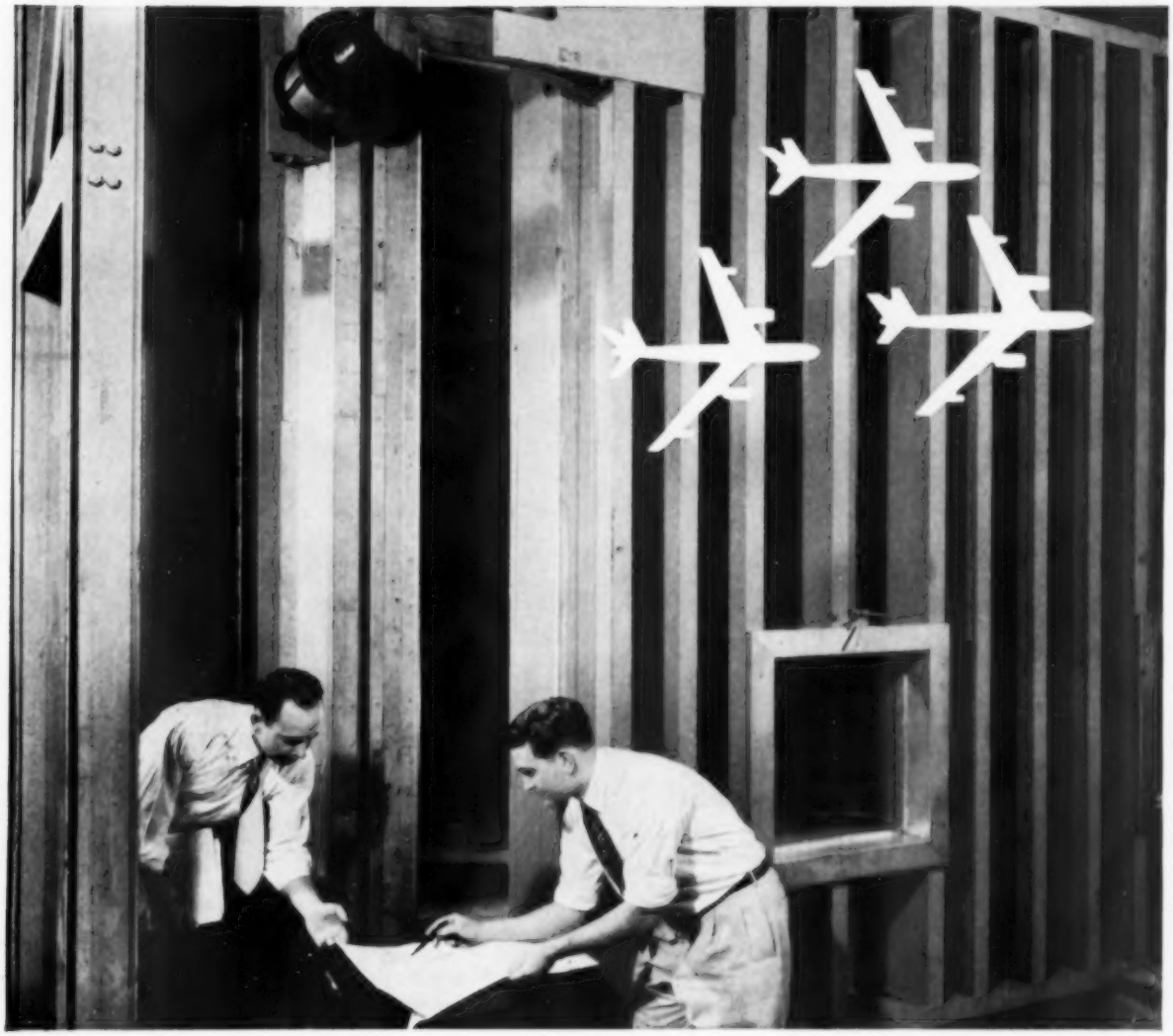
In so far as lubricants are concerned, both Teflon and colloidal graphite gave equivalent die fill. Conditions for 403 stainless and 4340 steel that were found best were 2,150 degrees Fahrenheit on the billet and 900 degrees Fahrenheit on the die.

M. E. Dougherty, Acheson Colloids Company, reporting for the Subcommittee on Heavy Presswork, said that since Battelle Institute had the Air Force contract, the subcommittee apparently was not needed. It was continued, however, in case a need for help on lubricants should develop in the future.

It was reported that glass is being used as a lubricant in tube and wire drawing. Universal Cyclops Company has the process, and the glass is sprayed in the molten state.

Karl Braeuninger, Dow Chemical Company, confirmed colloidal graphite as a lubricant and stressed the method of application. His work involved grinding aluminum, and he applied colloidal graphite while the piece was being ground so as to supply the graphite before the aluminum oxidized. A 500-to-1 improvement was noted. The material used is a special finely divided colloidal graphite and is suspended in slightly alkaline distilled water.

The meeting adjourned at 12:30 p.m., and following lunch at the officers' mess a tour of the base was made. This included observation of base facilities.



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NEW DEVELOPMENTS

MINIATURE WALKIE-TALKIE

The smallest walkie-talkie FM radio ever built—a transistorized instrument tiny enough to be carried in a shirt pocket or strapped to a helmet, yet powerful enough for 2-way communication over a quarter-mile range—has been developed experimentally by the Radio Corporation of America.

Tiny transceiver can be strapped to soldier's helmet.

The Army Signal Corps has purchased a quantity of the developmental walkie-talkie radios for field tests and evaluation as communications devices for squads and other small tactical military groups in the field. Tests are being conducted by the Operations Research Office, Department of Defense, at Fort Carson, Colo.

A completely self-contained and self-powered radio, the transceiver, as it is known, houses a receiver-transmitter, microphone-earphone, collapsible antenna, and a battery in a single compact assembly which weighs only fifteen ounces and approximates a small tobacco tin in size. It measures only 5½ inches high, 3 inches wide, and 1 inch deep.

ARMY GUERRILLAS

For the first time in its history the Army has created a corps of special troops trained chiefly to fight as guerrillas deep inside enemy territory. Formed in 1952, the existence of the tough, rigorously conditioned Special Forces Group, Airborne, was only recently made public by the Army.

The men of this outfit are described by their superiors as even tougher and more skilled in combat than the U. S. Rangers and British Commandos of World War II who, unlike the new group, fought primarily as shock troops rather than guerrillas. In the event of war, the Special Forces would be parachuted inside enemy borders to fight alongside local guerrilla groups.

All Special Forces soldiers had to volunteer as paratroopers before also volunteering for this assignment.

The 77th Special Forces Group, Airborne, is now in training at Fort Bragg, N. C., under the supervision of the Army's Psychological Warfare Center. Another group, the 10th, is in Germany. Each consists of about 2,000 men.

The aim is to make Special Force soldiers the most diversely trained in the world. They are organized into 15-man teams—2 officers and 13 enlisted men—who have the knowledge and equipment to direct large-scale guerrilla operations. A group has 100 of these teams in its table of organization.

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New Developments

LENSLESS GOGGLES

Lensless goggles developed by the Navy for use in extremely low temperatures are being tested in the Antarctic as part of Operation Deepfreeze. The lenses of conventional goggles become fogged rapidly by condensation of moisture evaporated from the eyes at low temperatures. In the Navy's experimental type, the lenses are omitted and a transparent plastic kidney-shaped cylinder is fitted to a foam-rubber frame. The open-end cylinder projects directly forward to shield the eyes, and stagnant air within the cylinder deflects the wind.

SPEEDY CONVERTIPLANE

McDonnell Aircraft Corporation's experimental "convertiplane" smashed the world's speed record for helicopters on its first conversion flight. Officially labeled the XV-1, the convertiplane is a combined helicopter and conventional fixed-wing aircraft. It attained a forward speed of more than 180 miles an hour. The previous speed record for helicopters was 156 m.p.h.

In the XV-1 an overhead rotor similar to those on helicopters is used for vertical flight. A pusher-type propeller and aircraft wings permit forward flight. The rotor is driven by pressure jets—one at each tip of the three blades.

NEW BRIDGE TRAILER

A special trailer has been developed by the Corps of Engineers' Research and Development Laboratories, Fort Belvoir, Va., to transport and launch a complete

Army photo

Complete bay launched by trailer.

bay of the Army's new division floating bridge. Towed by a standard 5-ton bridge truck, it features a tilting bed with rollers which facilitate the launching of an assembled bay into the water.

The rollers can be locked to prevent rotation while transporting a "ready" bay, and can be retracted to provide a flat bed for an unassembled bay of bridge. Construction of complete bays on trailers in a rear assembly area eliminates the need for a crane at the site and speeds erection at rates never before approached with the bridge.

CERAMIC TRANSDUCERS

The National Bureau of Standards has developed several lead-oxide based piezo-

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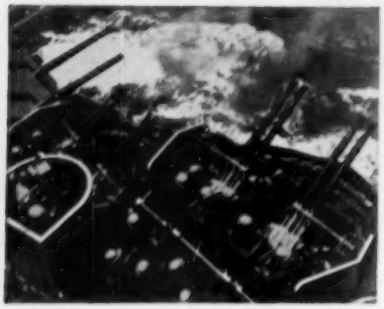

For dependable service and outstanding leadership both in meeting government specifications and in industry . . . the name of Anderol synthetic lubricants leads all others. Throughout World War II, the Lehigh Chemical Company developed and produced greases, oils, rust preventives and cleaning compounds for the Army and Navy, including almost one-third of a special machine gun oil required by the armed services. The company also manufactured synthetic petroleum sulfonates and special additives for the general lubricant industry. Lehigh has been producing synthetic lubricants in commercial quantities since 1944—considerably longer than any other manufacturer.

Anderol products include lubricating oil, grease, damping fluid, and slushing compound. In addition to these four typical products, a great many lubricants such as metal cleaners, degreasing solvents, emulsion cleaners, thixotropic oils, additives and special greases resistant to acids, solvents or water are also available.

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New Developments

electric ceramics that have excellent electromechanical properties and are stable over a wide temperature range. Some of these compositions, particularly in the lead titanate-lead zirconate system and the lead titanate-lead zirconate-lead oxide-tin oxide system, are expected to find considerable application as transducers for sensing elements in accelerometers, sound detectors, sonar, velocimeters, strain and pressure gages, and as drivers in ultrasonic devices. These materials can be expected to replace barium titanate in many commercial applications and to extend the use of ceramic transducers.

VOICE-POWERED RADIO

The power of the human voice has been tapped by the Army Signal Corps Engineering Laboratory, Fort Monmouth, N. J., to operate a new radio-telephone device.

Completely independent of wires and batteries, the voice-operated equipment weighs only a pound and a half and continues to operate as long as the user keeps talking into it.

The technique employed puts the voice to work so that it both runs and operates a transistorized transmitter. After speech syllables strike the microphone, part of the power is filtered to operate the radio-telephone while the rest puts "intelligence" into the signal it sends out.

At the present stage of testing, this new kind of energy does a competent job up to 600 feet.

Further development plans call for a companion receiver weighing about three ounces which could be powered by the same source. Voice energy would be built up and stored in the set when sending and used later for receiving.

SUB TRAINING DEVICE

Submariners of the future will be able to go to sea thoroughly versed in the intricacies of steering a ship in a 3-dimensional element, thanks to a new training device conceived by the Navy's Office of Naval Research. The new trainer is designed to teach submarine planesmen how to operate the single-stick control recently introduced into submarine construction. This control, so new that it has been installed on less than a dozen of Uncle Sam's submarines, gives underwater navigation many of the characteristics of flying an aircraft.

In the past, one man steered the ship to left or right, as on a surface vessel, while two other men operated planes forward and aft to steer the sub up or down. With the new method, one man using a device like the stick control of an airplane can do the whole job.

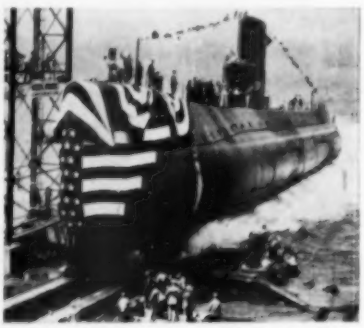
TITANIUM RESEARCH

The Department of Defense is reported to be planning a large research and development program in titanium to supplement its program of the last ten years. In addition, the Government expects to initiate an extensive program of titanium sheet rolling within the next few months in order to bring promising new alloys to industry users in the shortest possible time. The sheet-rolling program will involve "millions of dollars" and will serve as a connecting link between laboratory work and industrial application.

DATA PROCESSING MACHINE

An advanced type of electronic data processing machine is being used at the Electric Boat Division of General Dynamics Corporation in the design of the SEAWOLF, the nation's newest atomic-powered submarine. The new equipment, an IBM 650 magnetic drum data processing machine, contains a memory unit capable of storing up to 20,000 digits and is able to do mathematical calculations more rapidly than could previous calculators used in the design of the U.S.S. NAUTILUS, the first atomic submersible.

The new machine will be used to solve



Launching of U.S.S. SEAWOLF.

problems in radiation technology and health physics—for instance in determining the nuclear shielding requirements inside the vessel. It also will be used to help engineers make vibration-frequency analyses on equipment to be mounted in the submarine. These studies are particularly critical in a combat ship. Any noise generated by the ship could be detected by the enemy, so the vessel must operate as quietly as possible.

The machine also will be employed to calculate expansion reactions and stresses in the submarine's piping systems and to solve heat-transfer, structural-strength, and sound-attenuation problems.

At present the new data-processing machine is installed in temporary quarters at Electric Boat. Eventually, however, it will be moved into the division's new research center, which will be completed at Groton, Conn., early next year.

TINY AIRCRAFT DETECTOR

An electronic aircraft detector—so light and compact it can be hooked on a helmet—has been unveiled by the Air Research

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New Developments

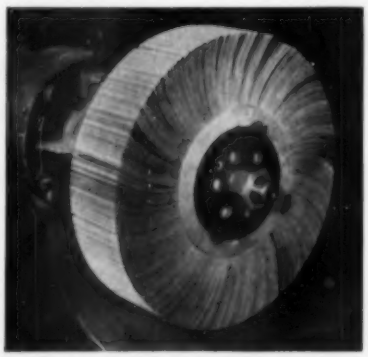
and Development Command. It is for use primarily by the Ground Observer Corps to spot low-flying enemy aircraft.

The detector weighs only twenty-four ounces and is mounted on hard plastic helmets similar to those worn by construction workers. On top is a small antenna that is controlled by a volume dial clipped to the left lapel of the spotter. The antenna registers any impulses it picks up in a small earpiece. Other detector apparatus includes a shoulder bag for its 4-ounce battery, a pulse amplifier, and a coaxial choke assembly.

If enemy aircraft managed to sneak through the vast radar warning system protecting the U. S. they would probably have their own radar gear operating. The small detector could pick up their radar impulses quickly and more accurately than the airplanes could be spotted by the human eye, especially when vision is limited by clouds and fog, or at night.

POLISHING-GRINDING WHEEL

A new device for polishing metal—which it is claimed cut polishing costs in one plant by one-fifth and in another outlasted setup wheels 60 to 1—has been developed



Wheel mounted on lathe spindle.

by Minnesota Mining and Manufacturing Company, St. Paul, Minn. It is said to make possible a new method for polishing all types of metal for plating, painting, or architectural finishing, without the use of fine-grit setup wheels, rag or sisal buffs, or brushes.

The device consists of hundreds of pieces of cloth coated abrasives factory-formed into a wheel that removes stock as part of its polishing action. This abrading-polishing action and the wheel's ability to conform enable it to remove mild draw marks and buff at the same time.

One of the major features of the wheel is that its rate of cut and the microinch finish it produces remain constant from the beginning of a new wheel until it is worn down to the hub. It is not necessary to increase arbor speed to maintain cut during the life of the wheel.

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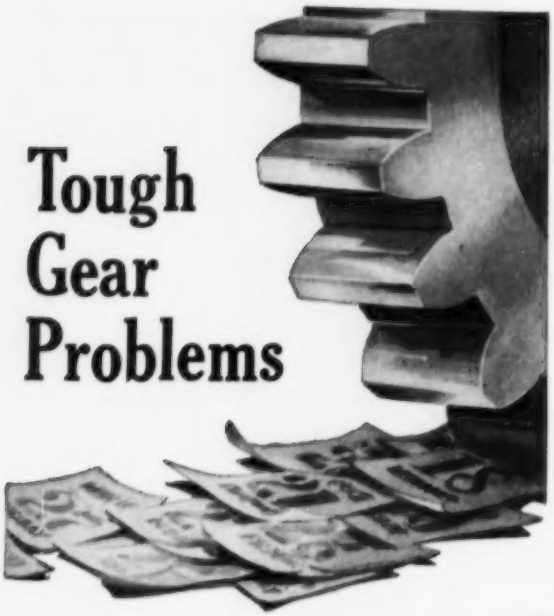

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MATERIALS PROGRESS

George S. Brady

Synthetic Mica.—Not less than six companies have been working intensively on synthetic and substitute micas, and the day seems fast approaching when the stockpile of natural mica will be as obsolete as the old-fashioned nightshirt. There is sound logic in this, because, no matter how plentiful imported natural mica may be, it is an almost unbelievably irregular product. Only as little as three per cent of a shipment may be high-grade electrical quality, and the hand labor of splitting, sorting, and grading is very expensive.

Taking up where the Germans left off after World War II, the Bureau of Mines did an outstanding job of improving on the process for producing synthetic mica by heat and pressure, and this process, with further improvements, has been employed by private companies, notably the *Mycalex Corporation of America*, Clifton, N. J. There is now no difficulty in producing high-grade uniform mica in flake form on a commercial basis at an economical price.

It is more difficult and costly to produce block or sheet micas, but it is now an open question whether or not it is worth while manufacturing block mica because with the synthetic block there remains still the very expensive hand-labor job of splitting the block into usable sheets, and the sheets cannot possibly have the uniformity of manufactured sheets.

Scientists continue to experiment on the production of mica block, but practical men at the manufacturing level almost universally feel that the final answer lies in the bonding together of high-grade flake into continuous sheets.

Natural mica flake is plentiful in this country, without need for importation, and it is relatively easy to clean the flake and free it of harmful iron inclusions. But there are some advantages to synthetic flake.

The general chemical formula for mica indicates that there are at least 600 possible variations of mica, and thus a synthetic mica flake can be made to suit any needed condition, whether for high heat, chemical resistance, or high dielectric strength.

Four chemical types already have been selected as most suitable for meeting present needs, and one of these, a fluorine mica, does not occur in nature in quantity.

Bonded mica sheets are limited in temperature uses to heats below the softening point of the bonding agent, and most of the early bonded micas were good only for applications at comparatively low temperatures.

A new grade of Isomica, of the *Mica Insulator Company*, Schenectady, N. Y., is made with natural mica flake bonded with an epoxy resin. It has a dielectric strength of 1,000 volts per mil, equal to the best grades of natural mica, is uniform and free from voids or metallic inclusions, and will withstand high pressures to a temperature of 300 degrees Fahrenheit.

Another new mica sheet, produced as Supramica by the Mycalex Corporation is made of synthetic mica flake of high dielectric quality bonded with an electrical-type glass. It will withstand temperatures to 1,000 degrees Fahrenheit, which is superior to good natural mica.

Navy scientists are sufficiently convinced of the practicability of bonding mica flake into sheets by recrystallization without any binder so that the Navy research contract with the *Sylvania Electrical Products Company* has been renewed. Details are not published, but it is known that the mica flake being used is a heat-resistant electrical-quality grade of synthetic mica produced by the Mycalex Corporation and that, because of pressure

(*Continued on p. 469*)

UNITED

35,000 TON FORGING PRESS

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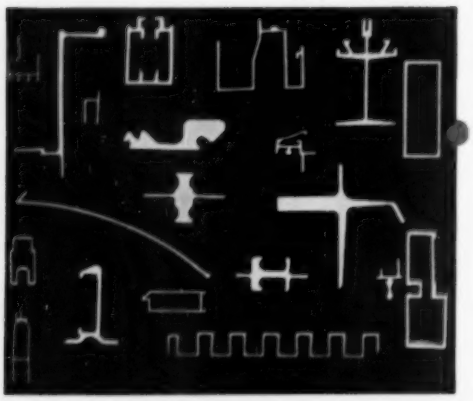

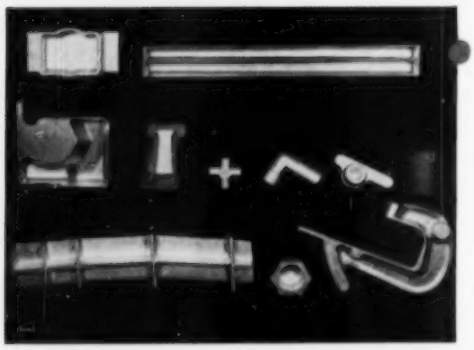

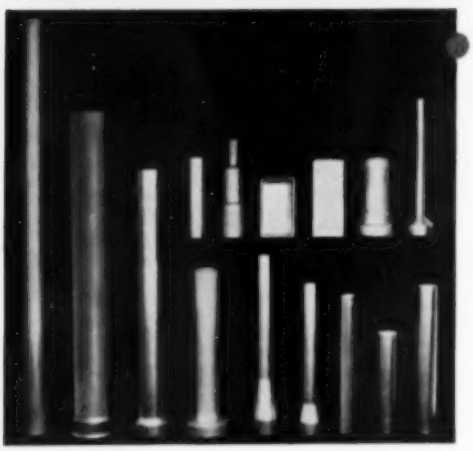

Here are a few of the many ways Harvey Aluminum makes your product easier to manufacture, easier to sell . . . saves you time, material, and manpower . . .

EXTRUSIONS . . . For decorative as well as basic parts, custom-designed aluminum extrusions replace riveted and welded assemblies . . . simultaneously increase strength and simplify fabrication.

STRUCTURALS . . . High strength, light weight, workability, corrosion resistance. Aluminum extrusions combine all four . . . are ideal as basic load-bearing members.

MACHINING STOCK . . . Harvey deep-drawn hex and round stock set a new mark in uniform grain structure—consistent from surface to core. This means fast, chatter-free cutting, long tool life, few rejects and true threads.

PRESS FORGINGS . . . Where parts must combine maximum strength with savings in weight, cost and manpower, Harvey aluminum forgings often completely solve a designer's problem.

FORGING STOCK . . . If you make your own forgings in quantity, Harvey extruded forging stock can save many intermediate steps. Custom-designed extrusions whose cross sections approximate the forged blanks may be cut to length.

EXTRUDED PIPE AND TUBE . . . Seamless . . . uniform in structure, size and shape . . . clean and smooth inside and out . . . easily formed. Usable in applications ranging from portable irrigation systems to aircraft heat exchangers.

IMPACT EXTRUSIONS . . . Thin-walled, tubular structures can be produced by this method and held to very close tolerances. Machining is practically eliminated, and scrap is greatly reduced.

DRAWN TUBE . . . Combines strength and high finish . . . ideal for TV antennas, furniture, and similar products. Cold drawn for structural uniformity . . . temper specially controlled for workability.

AUTOMATIC SCREW MACHINE PRODUCTS . . . The West's largest installation of multiple-spindle screw machines can reduce your manufacturing costs. Harvey carries your job through every step —from engineering through quality control.

Harvey is a leading independent producer of aluminum extrusions in all alloys and all sizes, special extrusions, press forgings, hollow sections, structurals, rod and bar, forging stock, pipe, tube, impact extrusions, aluminum screw machine products and related products. Also similar products in alloy steel and titanium on application.

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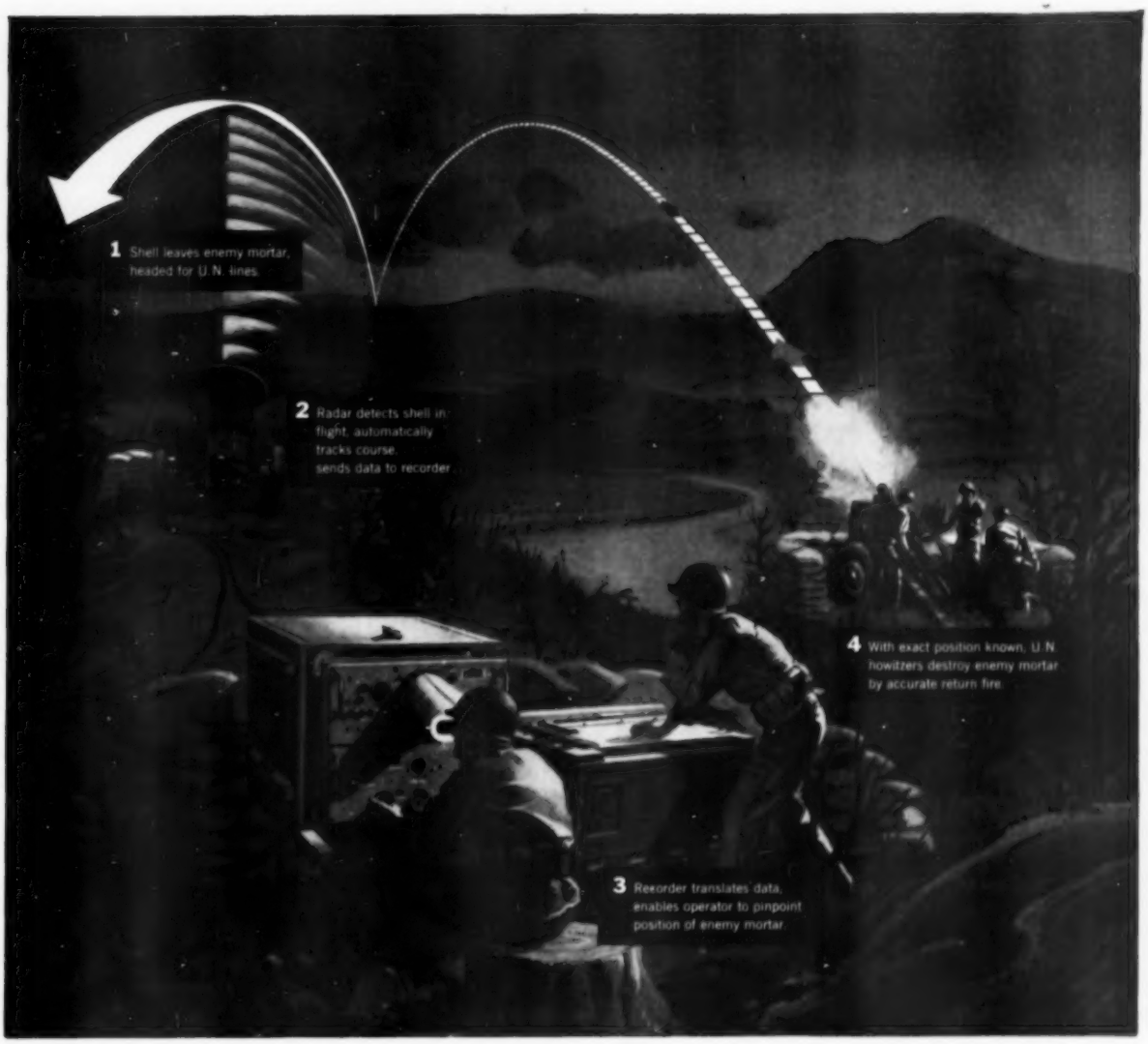
HARVEY Aluminum

HARVEY ALUMINUM SALES, INC., TORRANCE, CALIFORNIA—BRANCH OFFICES IN PRINCIPAL CITIES


1 Shell leaves enemy mortar, headed for U.N. lines.
2 Radar detects shell in flight, automatically tracks course, sends data to recorder.
3 Recorder translates data, enables operator to pinpoint position of enemy mortar.
4 With exact position known, U.N. howitzers destroy enemy mortar by accurate return fire.

ENEMIES' MORTARS LOCATED BY RADAR

Army Used Device Against Reds in Korea, NY TIMES, DEC. 12, 1954

THE STORY BEHIND THE STORY:

■ "Hundreds of soldiers now returned safely from Korea literally owe their lives to the extreme accuracy and speed of the new counter-mortar system." This good news was revealed by the Signal Corps in December when the public first learned of the existence of the MPQ-10 Mortar Locator, one of the Army's best kept secrets.

■ How could a carefully concealed enemy mortar be located and destroyed after just one or two shells had been fired? And how could such devastating accuracy be repeated over and over again—no matter how often the enemy relocated his mortars? These were important questions in Korea.

■ Actually, the uncanny efficiency of the MPQ-10 Mortar Locator was due to the joint efforts of the Army Signal Corps and Sperry engineers. Working together, they developed a new portable radar system for use at the front lines. How does it work? An automatic radar tracker detects and "locks on" the path of enemy mortar shells. In effect, it traces each shell back through its trajectory and reveals the enemy position. This information is then relayed to an artillery fire direction center which directs a return barrage against the enemy mortar in a matter of minutes.

■ Delivering this Mortar Locator to the troops is another example of Sperry engineering and production solving a problem to meet a critical need. Today, in the air, at sea, as well as on land, Sperry is helping extend our nation's capabilities with instruments, controls and systems for all branches of the military as well as for important segments of industry.

SPERRY GYROSCOPE COMPANY

DIVISION OF THE SPERRY CORPORATION · GREAT NECK, N. Y.

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here's what they can mean on your job

The new 286-HP CAT® D9 Tractor

Choice of torque converter or oil clutch drive. First track-type tractor with Turbocharger. Completely new 286-HP engine. "Live-shaft" drive for rear-mounted equipment. Many other important features.

The new 191-HP D8

With torque converter (Series D). With exclusive oil clutch drive (Series E). Completely new 191-HP engine. "Live-shaft" drive for rear-mounted equipment independent of flywheel clutch. New easy-working controls. Many other improvements.

The new 128-HP D7 Series C

Gear-type balancer gives six-cylinder smoothness. New 128-HP engine. Drawbar pull now 28,700 lb. maximum. New starting engine for simpler, easier operation. Track shoes hardened by "water quench" process. And many other important advances.

The year's biggest news on tracks: Caterpillar's three great new Diesel Tractors.

They're big news because they give you greater power and better performance than ever before.

The D9 and D8, for example, give you your choice of torque converter or exclusive oil clutch drive so you can best match your machine to your own job requirements.

All three give you features like one-piece frame-steering clutch case assemblies, and track shoes specially hardened by a new "water quench" process which means longer shoe life.

All three are easier to operate, with simpler, more powerful starting engines, easier working controls and other improvements.

They're easier to service, too; an exclusive trouble-free oil clutch, separately removable power train components and a fuel system that needs no adjustments in the field are only three of many reasons why.

Better be sure you get *all* the news about the new D7, D8 and D9. Call your Caterpillar Dealer today. Or mail the coupon below.

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CATERPILLAR TRACTOR CO., Peoria, Illinois, U.S.A.

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THE NEW D9, D8 AND D7 —EXAMPLES OF CATERPILLAR LEADERSHIP IN ACTION

limitations on the electrodes only small sheets capable of yielding several tube insulators have so far been produced. The prospects for the future, however, are promising.

Mica Substitutes.—For low and medium temperatures, most of the applications of mica can be met with approved substitutes. Besides the resin-bonded sheeted micas, including one produced by the *General Electric Company* with a heat-resistant silicone bond, several companies are marketing tough and strong plastic sheets suitable for capacitors and other electrical applications.

The polyester Mylar film of *Du Pont* is available in thicknesses less than 0.001-inch, and its dielectric strength is 50 per cent greater than that of natural mica.

The Kelon-T of *W. S. Shamban & Company*, Culver City, Calif., is of Teflon plastic (tetrafluoro ethylene), and is being produced in sheets in thicknesses down to 0.005-inch and in widths to 24 inches. It has been used successfully as a dielectric for capacitors, motor slot lining, and other electrical applications.

Aluminum Wire.—Substitution of aluminum for copper for conductive wire is not new, and steel-cored aluminum line conductors make possible longer spans and have become standard for this purpose, but it has been more difficult to gain acceptance for aluminum for general wiring purposes. But now, with the price of copper high and tending upward, there is renewed interest in the substitution of aluminum for copper in the heavy-tonnage wire market where copper has been king.

With the lower conductivity of aluminum, the wire must be larger in diameter to carry the same current, but, with greatly improved insulation, over-all diameters are now kept down to the equivalent of the older copper insulated wires so that the wires fit into all standard recepticles.

Aluminum alloys with higher electrical conductivity also have been developed by several companies, latest of which is Alloy 6263 of *Revere Copper & Brass, Inc.*, New York, N. Y. The *General Electric Company* has been using aluminum wire for some armature windings, thus making considerable weight saving. Now, *Aluminum Company of America* plans to install new equipment at its Massena, N. Y., plant capable of adding another ten million pounds annually to its production of plastic-insulated and triplex-stranded aluminum wire.

Aluminum Wall Panel—To overcome high labor costs in the erection of industrial buildings, schools, hospitals, and office buildings, *Brown & Grist, Inc.*, Warwick, Va., is manufacturing and marketing aluminum window-wall panels with the glass installed.

The panel unit, the full height of the building, is simply placed on a concrete and steel foundation and welded to clips on the steel foundation and to the top of the steel building frame. A building with these aluminum-glass panels survived the 90-mile winds of Hurricane Hazel without injury.

Plastic Pipe.—One large producer of plastic pipe states that consumption of polyethylene pipe is now at a rate above 20,000,000 pounds a year and is pointing upward at an accelerating rate. At a conservative rate ratio of 5 to 1, that means that this one type of plastic is replacing annually around 100,000 tons of metals, saving particularly copper and the scarce strategic metals that enter into corrosion-resistant alloys.

With the superior bursting strength of the newly developed low-pressure-process polyethylenes (Super Dylan of the *Koppers Company* and Marlex 50 of the *Phillips Petroleum Company*), the suitability of this plastic for piping is now enhanced. The new plastic has a denser, closer-packed, and more crystalline molecular structure which adds strength and heat resistance.

Use of polyethylene for wire and cable covering is also ex-

THIS IS AETNA-STANDARD

SEAMLESS TUBE MILLS

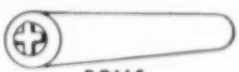
Aetna continues to conceive many new ideas for the production of seamless tubing. This continued progress, plus reputation and experience, helps Aetna-Standard to continue as world's leading designer and builder of Seamless Tube Mills.

FLAT-ROLLED FINISHING EQUIPMENT

This is one of Aetna's six major product lines. Flat-rolled embraces such equipment as: Shearing and Classifying; Scrubbing and Drying; Recoiling; Slitting and Side Trimming; Roller Levellers (two-high and four-high); Reels of all kinds; and many other products.

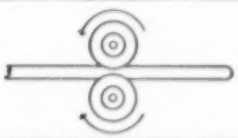
CONTINUOUS COATING

This year Aetna will have completed the building of 25 continuous galvanizing lines, in addition to several terne and electrolytic tinning lines. Aetna has worked closely with industry in this development and is considered the pioneer in continuous coating equipment.



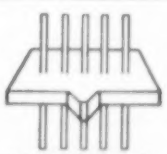
ROLLS

Aetna specializes in manufacture of small and medium-sized iron-base rolls. Aetna is pioneering in the use of Nodular Iron for rolls and castings under trade name of Magaloy.



CONTINUOUS BUTT WELD PIPE MILLS

Over the years, new ideas and engineering accomplishments have strengthened Aetna's position as the only builder in America of Continuous Butt Weld Pipe Mills. In recent months, Aetna Pipe Mill equipment has been installed in America, in Canada, in Germany, in England, in Japan and in Argentina.



COLD DRAWING

The world over, Aetna-Standard is recognized as the leading authority and builder of cold draw equipment for tubes and bars. This year marked introduction of several innovations by Aetna, such as the air gripper carriage and hook.

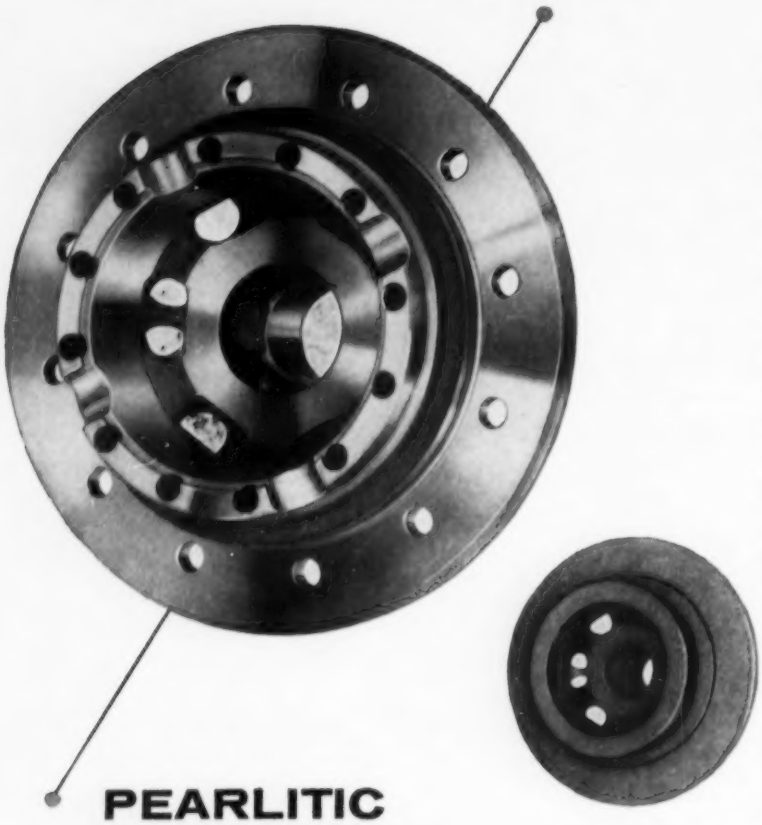
THE AETNA-STANDARD ENGINEERING COMPANY • PITTSBURGH, PA.

Aetna-Standard

PLANTS IN WARREN, OHIO • ELLWOOD CITY, PENNSYLVANIA

GOOD EQUIPMENT BRINGS DOWN PRODUCTION COSTS

MACHINABILITY INDEX 80-90*



PEARLITIC MALLEABLE CASTINGS

*B1112 STEEL = 100

Low machinability index of 80-90 (B1112 steel = 100) is probably reason enough to warrant serious consideration for your product.

But pearlitic malleable castings—from National—don't stop there. They have great ultimate strength . . . resist wear under heavy loads at high speeds . . . make excellent non-seizing bearings . . . can be air or liquid-quenched . . . can be smooth-finished.

Don't overlook the advantages of pearlitic malleable. For pearlitic malleable castings—from National—can often reduce manufacturing costs, weight and assembly time . . . can increase the sales potential of your product. AA-1806

NATIONAL MALLEABLE AND STEEL CASTINGS COMPANY

Cleveland 6, Ohio

The Nation's largest independent producer of malleable and pearlitic malleable

Materials Progress

panding. About 3,000,000 pounds of polyethylene are used in the new 2,000-mile telephone cable linking Newfoundland with Scotland.

Pure Calcium Hydride.—A new process for producing a 99 per cent pure highly reactive calcium hydride that may be the answer for a new, more economic way of producing titanium metal has been developed by *Metal Hydrides*, Beverly, Mass. The new process does not produce lumps, as with other methods, but yields a finely powdered calcium hydride dispersed in common salt.

Titanium metal powder produced experimentally by reduction with the hydride has been made into sheet equal in quality to that produced by Kroll-method titanium.

Chromium Plating Titanium.—A process has been developed by the *Tiarco Corporation*, Clark, N. J., for depositing a plate of wear-resistant chromium on the hard-to-plate metal titanium. The method, known as the Baylig process, consists in a special preparation of the titanium surface followed by plating in a modification of the conventional chromium plating bath.

For gun parts it has been found that a plate of 0.0015- to 0.003-inch in thickness gives bearing surfaces with improved frictional qualities, the wear resistance of chromium, and improved corrosion resistance.

Flame Coating Metals.—A process for ceramic flame coating of metals, recently developed by the *Armour Research Foundation*, has been commercialized by *Continental Coatings Corporation*, Chicago, Ill. Alumina is one of the oxides most easily spray-coated with a flame gun. The metal does not have to be heated in a furnace as with vitreous enameling. The alumina coating is extremely hard and abrasion resistant and is resistant to chemicals and to high temperatures.

Zirconia coatings may also be applied by the same method, and they are highly heat resistant. The sprayed coatings can be used for such applications as pump, fan, and turbine blades for high temperatures or for protecting soft metals.

Enamel Coating.—The new Pre-Namel coating process of the *Parker Rust Proof Company*, Detroit, Mich., eliminates the need for a ground coat in porcelain enameling, saving about 30 per cent of production costs and giving a thinner enameled surface that will not chip or fray in the working or bending of the metal.

The metal to be enameled is given an alkali cleansing and a special phosphate pickle, and the Pre-Namel is sprayed or

(*Continued on p. 473*)

RADAR THAT PUTS THE FINGER ON STORMS

Raytheon Storm Detector Radar, the AN/CPS-9, locates storms up to 300 miles away, measures their distance, direction, height – indicates the presence of rain or snow. Storm Detector Radar was developed by Raytheon in cooperation with Signal Corps engineers for use by all military services. The "3-dimensional" picture provided by this unit is invaluable to the quick, precise forecasting demanded by modern military operations.

Civilian applications of this equipment will supply vital information to commercial airlines, power utilities and the U. S. Weather Bureau. Reliable, accurate, versatile, the Storm Detector Radar demonstrates again that Raytheon means . . . "Excellence in Electronics."

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The versatility of the USAF Tactical Air Command . . . its mobility and atomic capabilities . . . combine with Ground Support equipment to provide assurance of effectiveness ***when seconds mean survival .*** ▷ Ground Support equipment of unquestioned reliability is indispensable should the need of defense or retaliation demand that TAC "rise" to the occasion in protection of our freedom. ▷ Through design, development and manufacture, we have solved the most complex ground support problems . . . providing the Tactical Air Command with a self-propelled multi-purpose unit, which combines towing, testing, servicing and/or starting for all types of aircraft under the most difficult operational conditions. The M A-1 and other type ground support units. are now being used extensively by the USAF, Navy and Marines . . . and are ***consolidated for greater power and versatility.***

THE ALL-PURPOSE MA-1 HELPS GREATLY TO SOLVE THE MOBILITY PROBLEM . . . FOR ONE UNIT TAKES THE PLACE OF FOUR OR FIVE

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GROUND SUPPORT

This compact, self-propelled, multi-purpose unit performs all requirements of towing, testing, servicing and starting for jet aircraft.

- A. C. POWER . . . 30 KVA, 400 cycles, 3 phase and 10 KW 1 phase, close regulated.
- D. C. POWER . . . 28.5 volts, up to 2250 AMP. For split or single bus start and servicing.
- COMPRESSOR . . . Air supply up to 3500 psi, 13.5 CFM, 1,000 cu. in. reservoir.
- TOWING . . All-wheel drive vehicle with mechanical or torque converter transmission, as desired.

IN ACTIVE USE WITH U.S. AIR FORCE, NAVY AND MARINE UNITS . . . . Other models of single and multi-purpose ground support equipment are available with any combination of AC and DC power . . . high pressure air hydraulic systems and low pressure air . . . refrigeration and heating.

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Materials Progress

dipped on at 160 degrees Fahrenheit and fired at 1,450 degrees Fahrenheit. A white or colored cover coat can then be applied in the conventional manner.

Aluminum-cored Anode.—Lead anodes for chromium plating have had a core of copper to improve the conducting efficiency but have had the disadvantage of contaminating the bath if the copper becomes exposed. Now, the *Reynolds Metals Company*, Louisville, Ky., and *Knapp Mills, Inc.*, Wilmington, Del., have developed a lead anode with an aluminum core that has good conductivity and will not cause contamination.

High-temperature Conductors.—Sheathed conductors originally designed for jet engines to operate in highly corrosive atmospheres at temperatures to 2,000 degrees Fahrenheit are now being produced by the *Ferrod Manufacturing Company*, Batavia, Ill., for general industrial uses for such applications as thermocouples and signal wiring.

The conductors consist of from one to six wires embedded in crystalline magnesium oxide and encased in an alloy tubing. The cable may be had as small as ⅛-inch, and lengths may be to 15 feet. The wires are accurately positioned in the oxide to give a minimum spacing of 0.035-inch.

New Conveyor Belt.—A new white, grease-resistant conveyor belt, Style ROH, being produced by the *Victor Balata & Textile Company*, New York, N. Y., was designed for handling unwrapped foodstuffs in bakeries and food processing plants and is suitable for handling many types of sticky materials.

It is made of closely woven cotton duck impregnated with Hycar synthetic rubber and covered with a 1/32-inch coating of Hycar. It comes in 2-, 3-, and 4-ply, will withstand continuous heat to 250 degrees Fahrenheit and intermittent heat to 325 degrees, and it can be steamed-cleaned.

Continuous Rubber Curing.—A new process, called Rotocure, for curing rubber continuously is being employed by the *Boston Woven Hose & Rubber Company*, Boston, Mass. The company is now offering continuous-process sheet rubber in thicknesses from 1/16-inch to 2 inches in widths to 72 inches for such uses as gaskets, bumpers, isolation, and insulation pads.

Colored Aluminum Paint.—Aluminum paint is now available in colors. *Gilmore & Nolan, Inc.*, Los Angeles, Calif., is offering the metallic paint in blue, green, and gold, and a full range of colors is expected to be produced later. The paints retain the characteristics of high coverage, resistance to corrosive fumes, and durability, with the advantage of colors.

A special chemical additive is incorporated to prevent blotching or floating of the metal pigment, and the coating actually consists of five to ten layers of aluminum flake cemented together by a resin binder.

Protective Finishes.—The new Amercoat No. 87 corrosion-resistant protective finish of the *Amercoat Corporation*, South Gate, Calif., will give a 0.010-inch finish coating on metals with one brushing. The liquid has a vinyl resin base and will air dry to a smooth matte finish by solvent evaporation. It comes in black, gray, white, and aluminum.

Another corrosion-resistant and chemical-resistant finish in black, gray, red, and aluminum for wood, metal, or concrete, is Corrocote, of the *Chemical Coatings & Engineering Company*, Broomall, Pa. It has a Neoprene base, and can be applied by roller, brush, or spray, giving a coating 0.003- to 0.005-inch thick which is flexible and wear resistant.

Silicon Rectifiers.—A power rectifier for motors, battery chargers, and other low- and medium-voltage uses, made from silicon metal has been perfected by *Raytheon Manufacturing Company*, Waltham, Mass. The compact unit will convert 5 to 15 amperes of a.c. current to d.c. current with a minimum efficiency of 96 per cent and will withstand temperatures to 370 degrees Fahrenheit—a working range not possible with the selenium rectifier.

Power rectifiers of silicon crystals are also being produced by the *Bogue Electric Manufacturing Company*, Paterson, N. J. The units are tiny compared with selenium rectifiers, are hermetically sealed, and have a 99 per cent efficiency. The silicon rectifier, which only two years ago was considered a dream of the future, is now rapidly replacing the more bulky and less efficient rectifier made from the scarce strategic selenium.

Nylon Tubes.—For the fabrication of rings, bearings, ring gears, and other round parts with little machining, the *Polymer Corporation*, Reading, Pa., is now producing a line of nylon tubes from 2 to 10 inches in diameter with wall thicknesses from ⅛- to 1 inch. The plastic tubes are centrifugally cast and are accurately turned and bored and are annealed.

Abrasive Cloth.—A new abrasive cloth of the *Minnesota Mining & Manufacturing Company*, St. Paul, Minn., called Fabricut, has the abrasive on an open-weave cloth which reduces the tendency to clog. It also permits cleaning with a compressed air stream. The abrasive grains may be either aluminum oxide or silicon carbide in 100 to 400 mesh.

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RECENT PATENTS

This department on recent military-industrial patents is being published in ORDNANCE *to keep our readers informed of the latest developments in these fields. The data are compiled by Melvin Nord, patent attorney, Detroit, Mich. Copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents each.*—THE EDITORS.

RIGID EXPLOSIVE CARTRIDGE

• *U. S. Patent No. 2,709,407. Issued May 31, 1955, to Arthur J. Lowe. Assigned to Imperial Chemical Industries Ltd.*—This invention provides a rigid explosive cartridge in which a rigid detonating explosive is cast around a portion of the surface of a rigid explosive pellet booster. As shown in Figure 1, the pellet booster 5 (which may be formed by compression of cyclonite, pentaerythritol, or tetryl) is inverted over a mandrel 1, 1a, and rests on a rubber washer 4.

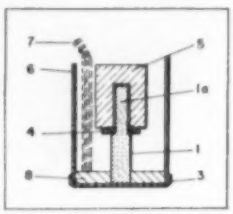

Fig. 1

The main explosive 7 (which may be trinitrotoluene, or a mixture of this with cyclonite or pentaerythritol tetranitrate) is shown being poured into the cartridge as a liquid, having attained a level 8 in the figure. Pouring is continued in stages, allowing solidification, to prevent flotation of the pellet booster.

JET FUEL ADDITIVE

• *U. S. Patent No. 2,712,496. Issued July 5, 1955, to Sol Skolnik and Howard W. Kruse. Assigned to the Secretary of the Navy.*—Aniline has the disadvantage, as a jet fuel, of freezing at 6.2 degrees below zero Centigrade and also of having an unduly long ignition delay. Both of these disadvantages are overcome by adding fifteen per cent of hydrazine to the aniline.

LOW TENSION IGNITER

• *U. S. Patent No. 2,708,877. Issued May 24, 1955, to Wijte B. Smits. Assigned to Smitsvonk N. V.*—This invention provides a very simple type of low-tension igniter for explosives. Two electrodes are separated by a cylinder of insulating material. The three cylinders are flush at the top, thereby providing a surface across which a spark may easily creep. The creep discharge of a condenser across the surface between the electrodes liberates the available energy in almost an explosive manner, having an extremely high ignition effect on the explosive charge. Low tensions, such as 500-1,000 volts are all that are required. The invention is claimed to have important applications in the firing of warship guns, machine guns, and remote-controlled mines.

PROPELLANT FOR ROCKETS

• *U. S. Patent No. 2,712,283. Issued July 5, 1955, to Sidney Golden. Assigned to the Secretary of Defense.*—In order to assure completion of burning within the projector tube of a rocket fired from a projector tube held in the hands of ground personnel, the burning time of the propellant is reduced.

AUTOMATION

AND
AUTOINSPECTION
SYSTEMS, CIRCUITS
AND CONTROLS
HAVE BEEN OUR
BUSINESS FOR
MORE THAN A
DECADE. IT
WILL PAY YOU
TO CHECK YOUR NEEDS
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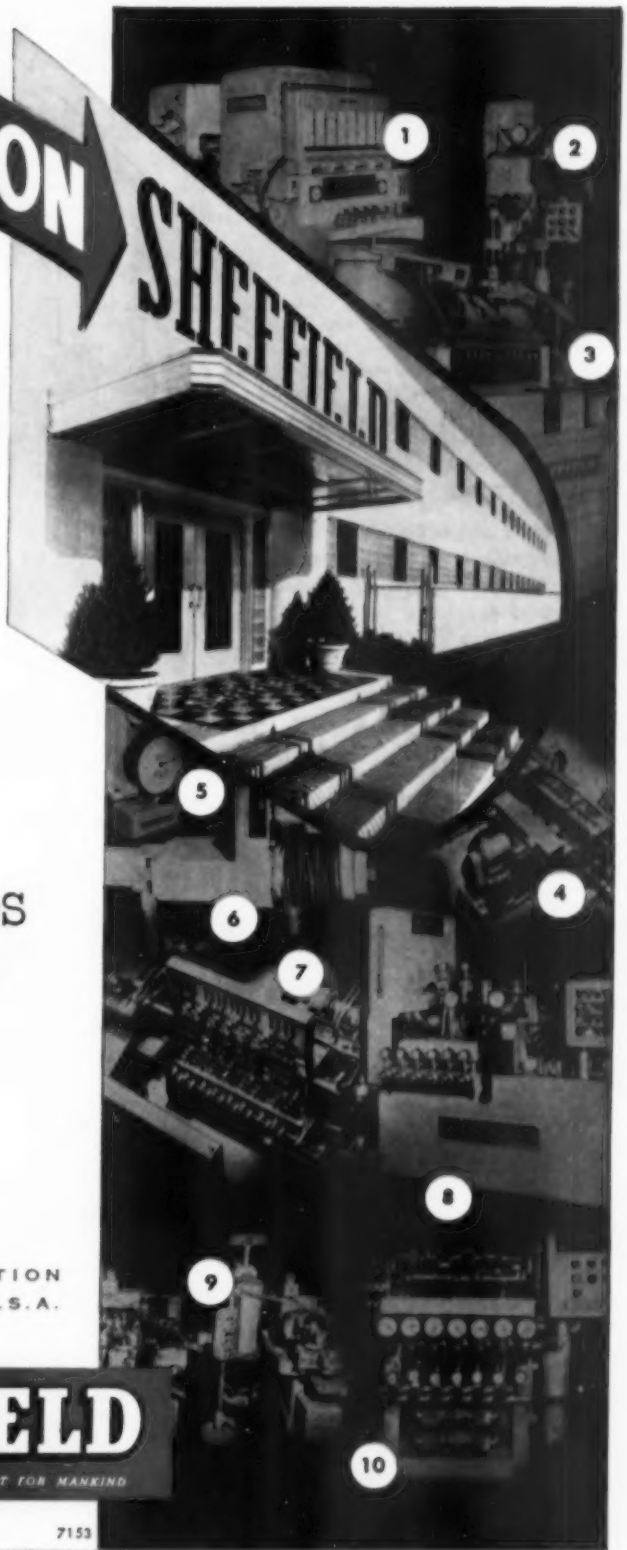

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3. Automatic gage for 100% inspection of small arms ammunition
4. Connecting rod inspection
5. Controlling the grinding of ball bearing races
6. Post-process size control of bearing races
7. In-line inspection of automobile part
8. Controlling 12 grinding machines
9. Controlling bore size of pinion blanks
10. Automatic gaging of crankshaft main bearings

EXPERIENCE

Recent Patents

The burning time depends on the operating pressure in the combustion chamber, and this normally depends on the ambient temperature. Thus, with a high ambient temperature, the pressure may be sufficient to blow out the walls of the motor chamber; and with a low ambient temperature, the burning time is increased sufficiently so that a sheet of flame is thrust back into the operator's face.

In the present invention, these difficulties are avoided by making the pressure independent of ambient temperature. According to the inventor, this is substantially accomplished by the use of propellant powder in the form of a number of rings or washers, together with proper proportioning of the combustion chamber.

MINE FIRING DEVICE

• *U. S. Patent No. 2,712,790. Issued July 12, 1955, to Jesse E. MacAdams.*—In amphibious warfare, a stretch of water may be mined with a number of isolated explosive charges equipped with the firing device described, and after the array of firing devices has become armed by action of the water, the explosion of a charge in proximity to the mined area will automatically set off all the firing devices. Advantage is taken in the patent of the special property of potassium carbonyl of exploding on contact with water.

AIRPLANE AND CONTROLS

• *U. S. Patent No. 2,712,420. Issued July 5, 1955, to Warren H. Amster, Clarence H. Holleman, and Eugene V. Browne. Assigned to Northrop Aircraft, Inc.*—

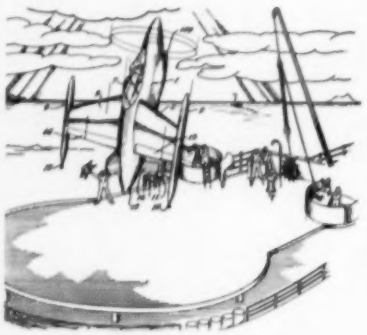

Fig. 2. Vertical take-off aircraft.

This invention describes a vertically landing (tail down), horizontally flying airplane, together with a control system for it. Figure 2 shows the aircraft in hovering position just above the take-off and landing deck of a vessel.

PROPELLANT COMPOSITION

• *U. S. Patent No. 2,712,989. Issued July 12, 1955, to Herman Maisner. Assigned to Aerojet-General Corporation.*—This patent provides a method of preparing nitroparaffin gel for use as a propellant in jet-propulsion devices by which the gels retain their consistency for a long time without undergoing any marked change.

IMPROVED JET FUEL

• *U. S. Patent No. 2,712,726. Issued July 12, 1955, to Homer M. Fox. Assigned to Phillips Petroleum Company.*—Improved engine starting and improved combustion efficiency over a wide range of temperatures can be obtained by adding a viscosity-index improver (E. G., Acryloid 710, Paratone, or Santodex) to the jet fuel.

BALLOON LAUNCHING

• *U. S. Patent No. 2,708,082. Issued May 10, 1955, to C. B. Moore and W. F. Huch. Assigned to the Secretary of the Army.*—A method of launching small meteorological balloons vertically without tipping, despite the presence of air currents, thus protecting instruments.

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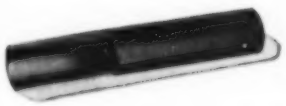

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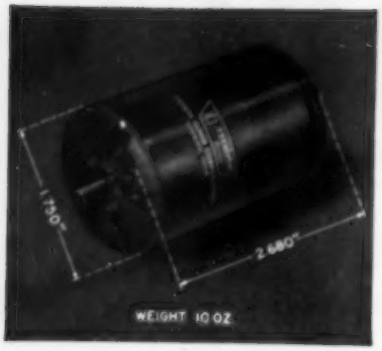

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- **can be coupled with synchros,** resolvers and other components – as well as ganged.
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Linearity Tolerance	±0.05%
Minimum Output Voltage Increment	0.01%
Output Impedance	less than 130 ohms
Input Voltage	130 v max.
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vernistat

division

PERKIN-ELMER CORPORATION

Norwalk, Connecticut

ARMAMENT ELECTRONICS

THE Ordnance officer is primarily concerned with the ruggedness of his weapons and their firepower capabilities, but good communications play a key part in obtaining maximum effective firepower from any weapon, be it a cannon, light artillery, or tank. Thus, of great interest to all ordnancemen who want to see their weapons used to their best advantage, is a recent development in the electronic military communications field.

A flexible, rugged, and transportable radio set has been developed by the Bell Laboratories and given the designation AN/TRC-24 in the armed forces. This set will serve as a link or repeating station between wire and radio voice communication. It is described in a recent article in the *Bell Laboratories Record* by A. L. Durkee, a research engineer who specializes in military applications. The pertinent parts of his article are quoted for the benefit of the ordnanceman.

"During World War II, a new type of general-purpose cable, called 'spiral four,' was made available for military use, together with a 4-channel carrier system to operate over the cable. Improved carrier systems have recently been developed for use on spiral four, capable of transmitting either four or twelve channels.

"To serve as an alternate for various wire and cable facilities, a transportable, multichannel radio relay system was needed. As one of the specifications, the Signal Corps required that such a system be usable directly with the new spiral-four carrier equipment.

"As a result, Radio Set AN/TRC-24 uses either the 4-channel (AN/TCC-3) or 12-channel (AN/TCC-7) terminal equipment of the cable carrier system, permitting radio and wire links to be integrated into communication lines up to 1,000 miles long.

A COMPLETE AN/TRC-24 radio set consists of a transmitter, a receiver, a transmitter power supply, transmitting and receiving antennas with reflectors and transmission lines, a 45-foot sectional mast to support the antennas, and an assortment of spare parts and accessories.

"All this equipment is packaged in a number of rugged, compact units designed for portability, and any package can be handled easily by two men. The equipment can withstand rough handling and will operate satisfactorily under any climatic conditions. It is designed to operate on 105-125 or 210-250 volts at 50 to 60 cycles. Power may be supplied from commercial lines or from a mobile engine-driven alternator.

"Since the radio relay system integrates with spiral-four equipment, the radio terminals use the carrier terminal units already available. The 4-channel terminal 'stacks' the voice channels frequencywise in the range from 4 to 20 kc., with a narrow-band order or service channel from 0.3 to 3.0 kc.

"The 12-channel terminal 'stacks' 12 channels in the range from 12 to 60 kc., and limits the service channel to 0.3-1.7 kc. A continuous pilot frequency at 68 kc. is used for regulation, and test frequencies at 12, 28, and 65 kc. are also used when they are needed.

"THE radio relay system finally evolved operates in the frequency range from 100 to 400 mc. and uses frequency modulation (FM). It is intended primarily for use on line-of-sight transmission paths up to about thirty miles in length. Two radio sets 'back-to-back' are used as a radio-frequency repeater to cover longer distances, and as many as 8 repeater sections can be used in tandem to form trunks about 200 miles long.

"A number of these trunks can also be connected together or with other facilities to form longer, more complex networks.

"For line-of-sight distances the frequency range from 100 to 400 mc. offers several advantages. These frequencies are not normally reflected from the ionosphere, and the 100 watts delivered by the AN/TRC-24 transmitter will not send them very far beyond the horizon. Interference, either natural or man-made, is thus minimized. Fading is comparatively mild on line-of-sight paths at these frequencies, and there is little or no atmospheric noise (static) to contend with.

"Between 100 and 225 mc., 250 radio channels are available, spaced 0.5-mc. center to center, and between 225 and 400 mc., 175 channels with 1-mc. center-to-center spacing. Channel selection and frequency control are accomplished with plug-in radio-frequency tuning units and a crystal circuit built into the radio transmitter.

"Harmonics of a 0.5-mc. or 1.0-mc. crystal oscillator are used to 'lock' the transmitted carrier at the proper frequency. The receiver is kept tuned to the incoming signal by an automatic frequency control circuit.

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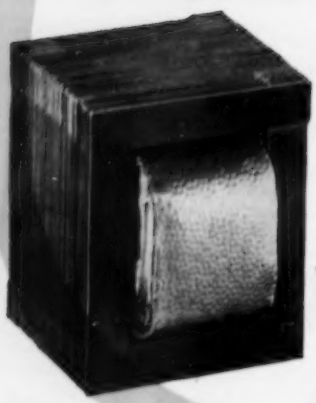

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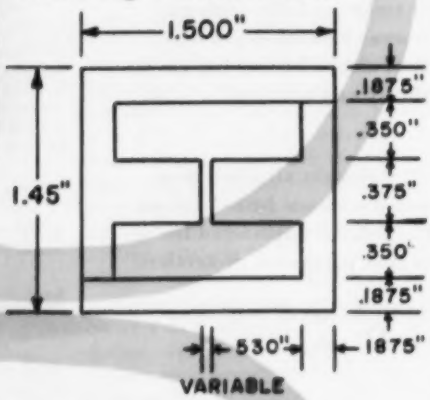

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Armament Electronics

"The availability of many channels and the ease with which channels can be changed permits considerable freedom in laying out a network so as to avoid interference. Of course, some restrictions must still be placed on the allocation of channels for each link in a relay system.

"If, however, the system is extended, the same frequency allocations may be used in subsequent sections provided those sections working on the same frequency are far enough apart to avoid overreach interference. Frequency assignments ordinarily can be repeated at intervals of about 100 miles."

ALTHOUGH AN/TRC-24 sets can be employed in tandem to give an over-all circuit 1,000 miles long, artillery missile and ordnance units would normally not require such great distances. This simplifies the problem of reducing distortion and noise in each repeating set so that the additive disturbances will not create an unmanageable circuit. Nevertheless the steps taken to achieve the best possible operating characteristics, as reported by Mr. Durkee, are of interest to all electronic engineers.

"Noise in a radio system arises from a number of sources," the article continues. "The principal contributions are: noise generated in the carrier terminal equipment, fluctuation noise produced in the radio receivers, external radio-frequency noise and interference, and intermodulation noise resulting from cross modulation of various components in the signal.

"Limits on the permissible levels of these several types of noise, consistent with the desired over-all noise performance, became the basis for determining such system parameters as transmitter power, antenna gain, carrier-frequency deviation, and radio-frequency band width.

"Intelligence transmitted by the radio system consists of either four or twelve telephone channels 'stacked' to form a wide-band signal. The use of amplitude modulation (AM) would require that the input amplitude versus output amplitude characteristic of radio repeaters be strictly linear, since amplitude variations of the AM wave must be faithfully preserved. With FM, the intelligence is determined by the frequency rather than the amplitude of the transmitted wave.

"The critical characteristics of an FM radio repeater are linearity of the phase versus frequency characteristic and flatness of the amplitude versus frequency characteristic over the transmitted band. Frequency modulation was selected as the most advantageous method, and the use of FM in the AN/TRC-24 system has made it possible to utilize up to 40 repeaters in tandem without serious degradation of the signal."

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ROCKETS AND GUIDED MISSILES

Alfred J. Zaehringer

Astronautics.—Astronautics, the science of space travel, has received new official impetus with the announcement that the United States would take part in the 1957-1958 International Geophysical Year research program by launching a small, unmanned earth satellite.

The satellite, to be placed into an orbit by rockets, would circle the earth at a speed estimated at near 18,000 miles an hour. The "bird," as it is called, will weigh about 100 pounds and house instruments to collect basic data about conditions 200 to 300 miles above the earth's surface.

The lifetime of the satellite will range from a few days to a few months—after this it will return to the earth. During the descent it probably will be burned up by friction with the atmosphere. However, the basic data collected by this artificial moon will be beamed back to stations on the earth during its short life.

This basic data collected during the Geophysical Year will be shared with all nations, although rocket data are expected to be classified.

U. S. Missiles.—Three long-range U.S.A.F. missiles are reported to be in various stages of development. The strategic missile, SM-62, *Snark* (Northrop Aircraft) is now being flight-tested at the U.S.A.F. long-range proving ground in Florida. Snark is a subsonic cruise missile with a range hinted at about 5,000 miles. It is said to cruise at an altitude of 40-45 thousand feet at a speed of 600 miles an hour. Power may be from a turbojet engine of 10,000 pounds' thrust.

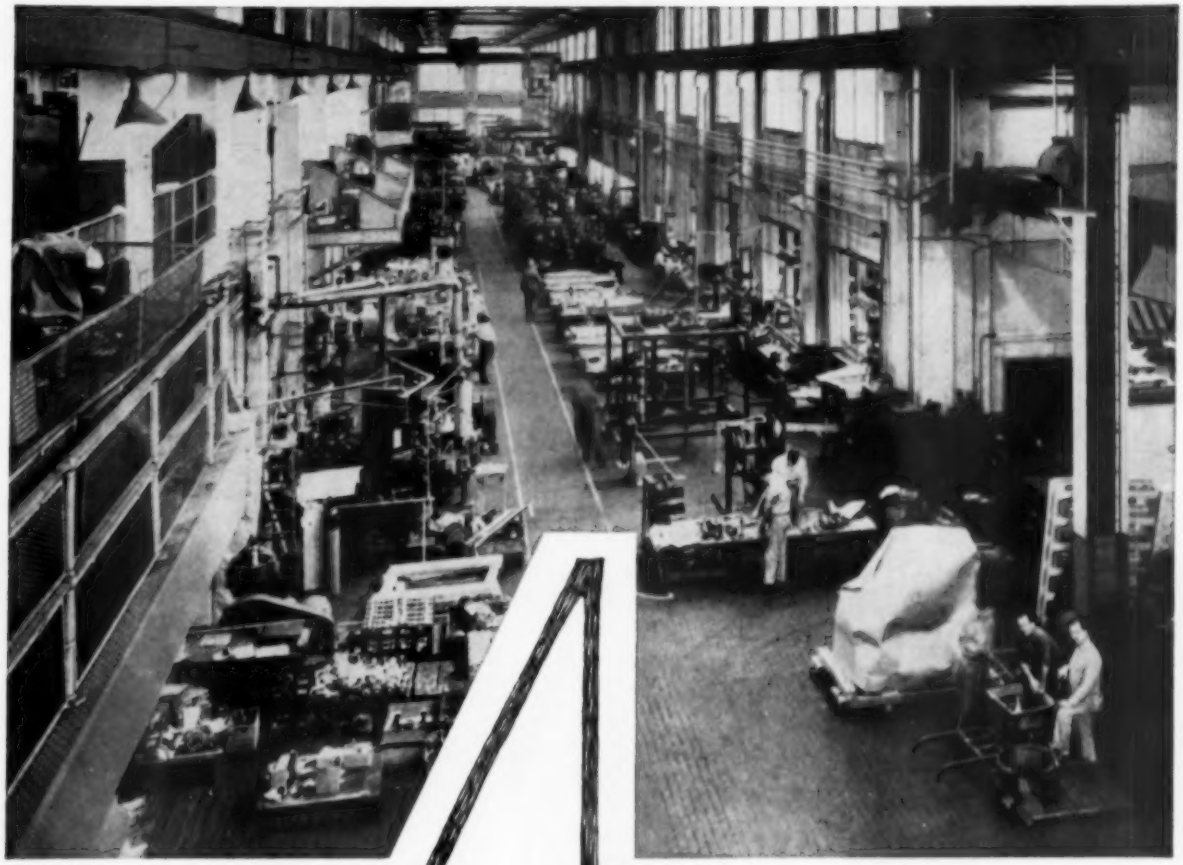
Snark is cigar-shaped, about 60 feet long, and its 45-degree sweptback wings have a span of 40 feet. The SM-62 is launched by means of high-thrust rato bottles from a zero-length launcher. Guidance is said to be by celestial navigation and an autopilot.

Navaho, SM-64, by North American Aviation, has received flight tests at Edwards Air Force Base, Calif., and is now to move over to the Florida test facility. The SM-64 is a supersonic cruise missile which may fly at speeds of 1,300 to 1,950 miles an hour and be able to span a range of 3,000-5,000 miles in 2½ to 3 hours. Unlike Snark, the Navaho takes off vertically.

Components of the SM-65 *Atlas* missile may be used in the establishment of the U. S. earth satellite. Engineers have visualized Atlas as a 2- or 3-stage rocket vehicle about 100 feet long and weighing in excess of 100 tons. Convair is responsible for the airframe and tanks; North American Aviation for the high-thrust rocket engines; General Electric for the guidance system; and Ramo-Wooldridge for teamwork on the missile.

Mobility is the keynote of our operational missiles. *Honest John*, the 762-mm. rocket, is already in Europe and is now being deployed in Japan and the Far East. In a recent tactical exercise, the Air Force airlifted a complete *Matador* tactical missile squadron from Germany to the Libyan desert in Africa. Firings took place near Tripoli.

Other missiles have been revealed. *La Crosse* is a surface-to-surface group-support missile. Developed by Cornell Aëronautical Laboratories, the weapon is to be produced for the Army and Marine Corps by G. L. Martin. Another missile, *Bulldog*, is to be produced by Martin for the Navy. Forerunner of this missile was the *Bullpup*, an air-to-surface missile powered by a solid-fuel rocket with a diameter of twelve inches and a length of eleven feet.



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Rockets and Guided Missiles

Wizard missile—for antiaircraft purposes—was revealed by the Willow Run Research Center of the University of Michigan. Although no details were given, it was stated that studies on the Wizard led to the development of the *Bomarc*.

Research.—Three rocket-sled developments have been highlighting the research scene. The rocket sled at Edwards Air Force Base, Calif., has established a track record of 1,608 feet a second (1,100 miles an hour). The 4,300-pound sled, which emitted a sharp sonic boom on its run, attained its peak speed in less than 5 seconds after the start.

The tremendous acceleration was supplied by two sets of solid-propellant booster rockets with burning times of 2.2 seconds each. The run was the first to give intact recovery of the sled after reaching a speed of over 1,000 m.p.h.

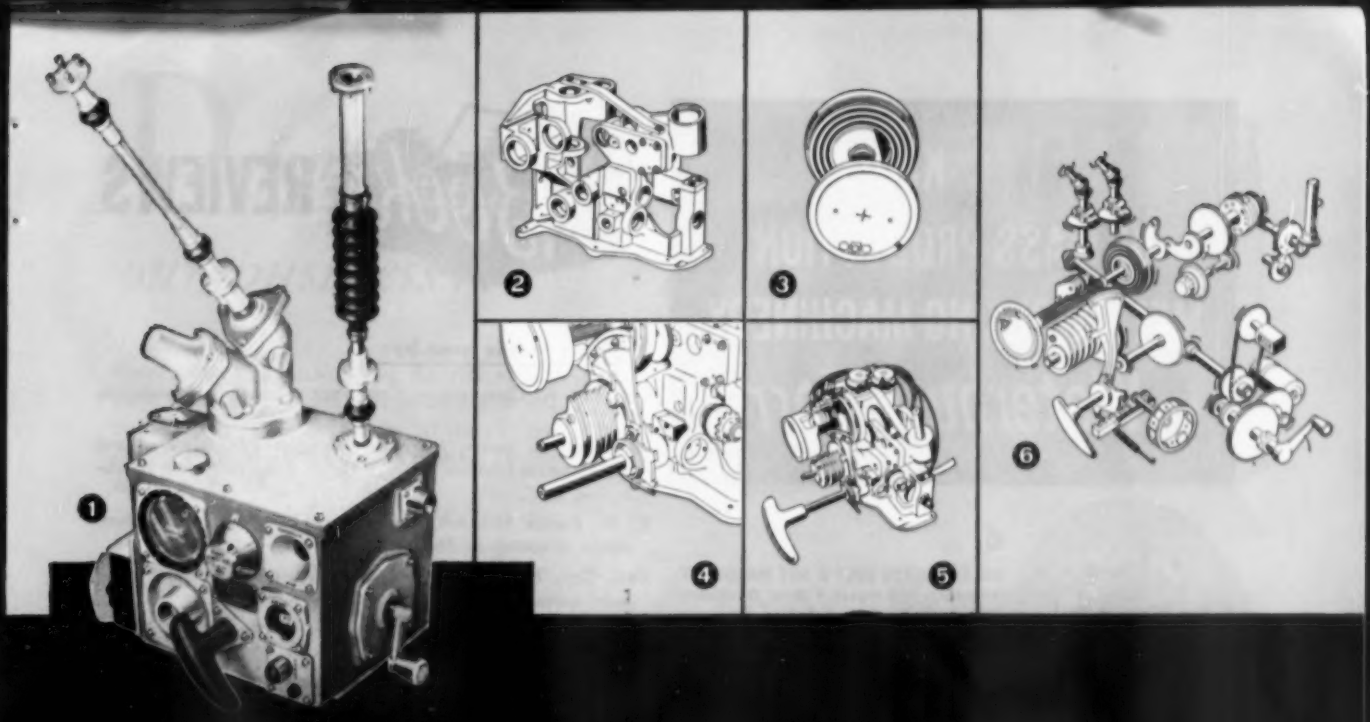
At the U. S. Naval Ordnance Test Station, Inyokern, China Lake, Calif., a new rocket sled is taking shape. The sled will be used to conduct flutter tests on present high-speed aircraft.

Finally, *Smart* (Supersonic Military Air Research Track) is a new U.S.A.F. rocket sled at Hurricane Mesa. The first successful run was made recently on the 2¼-mile-long track, located near Zion National Park, Utah. The primary purpose of the track is to develop emergency escape techniques for piloted supersonic aircraft. Unlike other rocket tracks, Smart was designed to provide free-flight conditions for test equipment and its recovery for further test. At the Smart facility, the test equipment is accelerated by a rocket sled and then catapulted over a 1,500-foot cliff and lowered by parachute to the desert floor where it is recovered.

Rocket activities during the forthcoming Geophysical Year will be many. Emphasis will be on collecting data such as cosmic-ray intensity, solar spectra, atmospheric conditions, gravitational and magnetic field intensities, etc., at high altitudes. *Aerobee-Hi* rockets, reaching altitudes of over 100 miles, are to be fired —25 at Fort Churchill, Canada, and 11 at Holloman Air Force Base, N. Mex.

In addition, 37 balloon-launched rockets —with altitude capabilities of up to 70 miles—are to be fired at Thule Air Force Base, Greenland, Fort Churchill, and Holloman AFB. An undisclosed number of aircraft-launched rockets are also to be fired in Alaska, Newfoundland, and Greenland.

Meanwhile the U.S.A.F. has attained what is probably a new altitude record for a solid-propellant rocket vehicle—70 miles. Called *Dan*, the vehicle uses the *Nike* booster as the lower stage and a *Deacon* rocket (7,500 pounds' thrust for 3.5 seconds) as the upper stage.



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- Bureau of Ordnance, U. S. Navy

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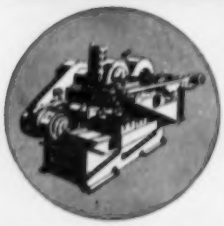

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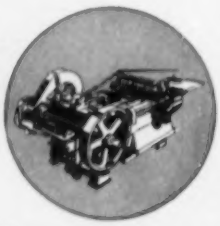
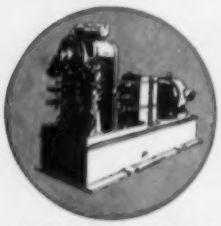
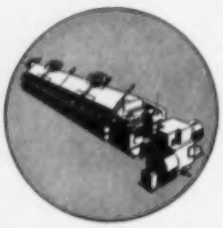


POWER PRESSES —Crank, Cam and Toggle; also Rack and Pinion Presses • Eyelet Machines • Multiple Plunger Presses • Horizontal and Hydraulic Presses, etc.

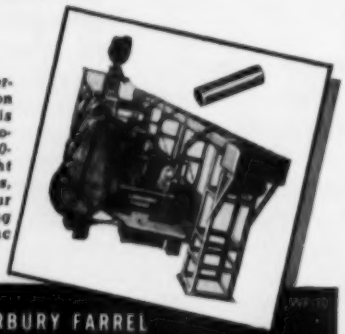


MILL MACHINERY — Rolling Mills: Strip, Rod, Tube, Wire Flattening, (For Ferrous and Non Ferrous Metals) • Also Slitters • Straighteners • Cut-off Saws • Coilers • Winders, etc.



WIRE MILL EQUIPMENT — Continuous Wire Drawing Machines (Upright Cone and Tandem) • Wire Flattening Mills • Chain Draw Benches • Pointers • Swagers • Bull Blocks • String-up Machines • Spoolers, etc.

SPECIAL MACHINERY — Sendzimir Mills • Small Arm Ammunition Machines • Thread Rolling Machines For Shells • Collapsible Tube Machines • Coining Mills, etc.



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Book REVIEWS

Reviews in this issue by:

COL. LEO A. CODD, *editor,* ORDNANCE *magazine, Washington, D. C.*

DR. JAMES B. EDSON, *consultant on electronics, Research and Development Division, Office, Chief of Army Ordnance, Washington, D. C.*

F. W. FOSTER GLEASON, *military historian, ordnance analyst, editor, Washington, D. C.*

BRIG. GEN. THOMAS K. VINCENT, U.S.A., Ret., *artillerist, engineer, author, Washington, D. C.*

R. J. WARFEL, *staff consultant, American Ordnance Association, Washington, D. C.*

CAPT. J. M. P. WRIGHT, U.S.N., Ret., *naval ordnance engineer, logistician, editor, Washington, D. C.*

Portrait of Patton. By Brig. Gen. Harry H. Semmes. New York: Appleton-Century-Crofts, Inc. 300 pp. $6.

THIS is a brand-new biography of one of our most talented and colorful military leaders. Followers of General Patton have that blind admiration for their hero which avidly awaits every new facet or episode in his historic military career. This reviewer is one such.

General Semmes, the author—a charter member of the American Ordnance Association—served under General Patton in the Tank Corps in the First World War and in the 2nd Armored Division in the Second World War. He is as proficient with the pen as with the gun and here has written a beautiful tribute to his former leader which places all Patton followers under renewed obligation.

He has made use of new material never before available which was released for the first time by the Patton heirs. There is a foreword by Ruth Ellen Totten, General Patton's daughter.

This book appears on the tenth anniversary of General Patton's death—a decade during which his already towering stature has grown to such merited proportions that his place among the great military leaders of all time is assured. His leadership is uncontested, his personification of battle mobility is conceded.

Patton and Rommel emerge from World War II to take their places high on the list of history's generals whose fame rests on the attack rather than defense, on movement rather than position, on gunnery accuracy rather than dispersed fire, on personal leadership and not absentee direction.

These characteristics stand out in General Semmes' book—a biography which traces the Patton story from his childhood in California to the tragic automobile accident in Germany which caused his death.—LEO A. CODD.

Principles of Nuclear Reactor Engineering. By Samuel Glasstone. New York: D. Van Nostrand Company. 872 pp. $7.95.

MY earlier years were spent among those who, "with string and spools and sealing wax," worked their rather lonely way toward the portals of the atomic age. This book, heavy in my hand and reciting with dry authority the engineering lore of nuclear power to be rote-learned by our young men, made me look back. Those portals to a new era are already almost as far in the

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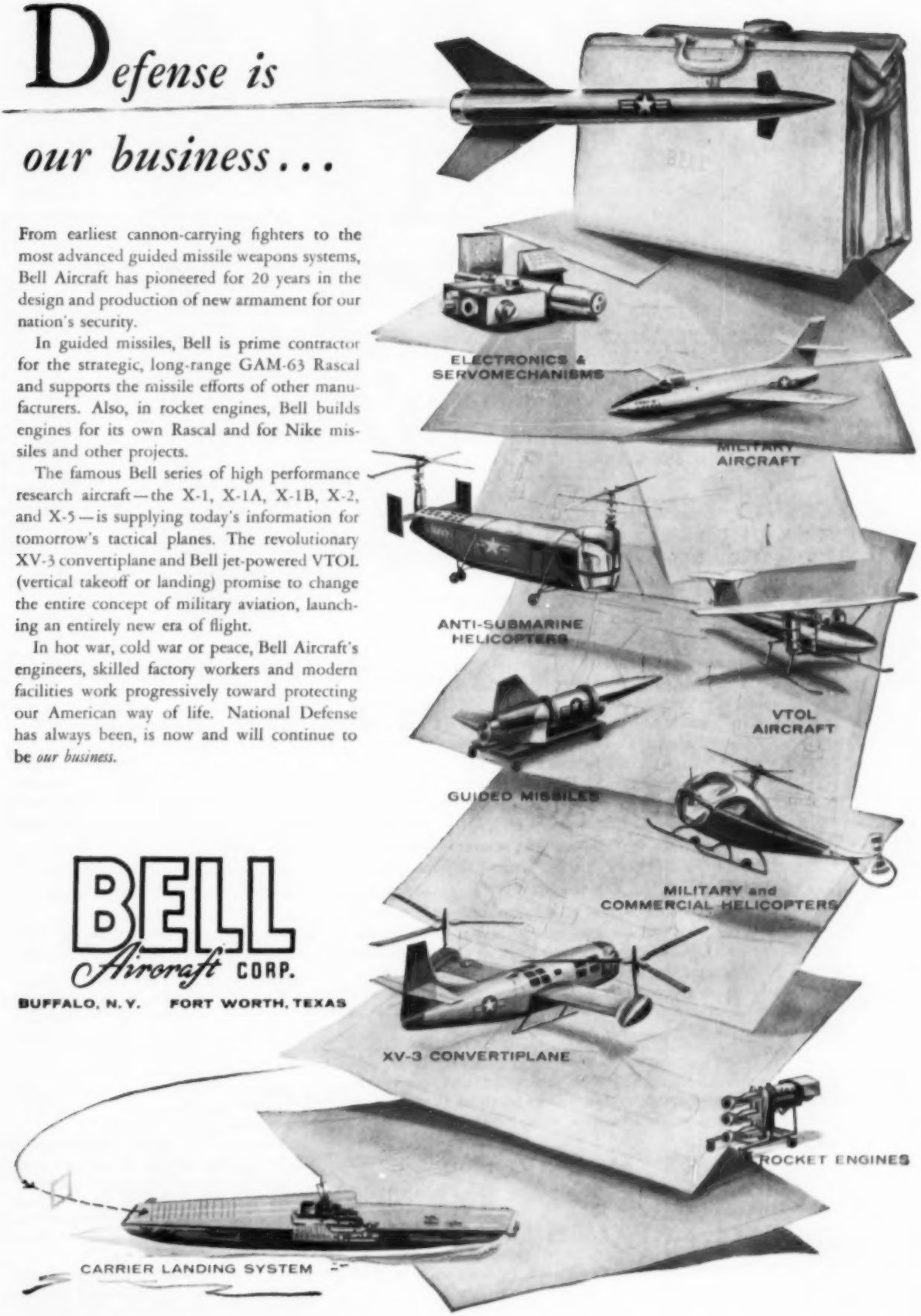

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Book Reviews

hazy past as they were in the mist of the future when first I shared the dream of them.

So, for a moment, I felt the cold breath of Time on the back of my neck. But it turned out instead to be only my own imagination, reading over my shoulder. Presently the old rascal was mumbling outrageous ideas about how this book and the young men could build us an Argosy for new adventures "beyond the paths of all the western stars." Could be, could be!

By this solid and authoritative AEC-sponsored text the new generation of reactor engineers will be trained. They in turn will do much to shape our atomic future. This volume may therefore be of interest to military and staff people with atomic-energy responsibilities as well as to the engineers and students for whom it was written.

Fortunately, the first and last two chapters of the book constitute a useful briefing on current reactor technology. There is also an interesting economic comparison of conventional with nuclear power plants. The concluding chapter describes a variety of existing and planned reactors and contains some engineering anecdotes about reactor operation.

The masterfully composed body of the book will prepare engineers and students for work in the reactor field. Topics include nuclear physics, reactor theory, control, instrumentation, heat flow, biological and physical safety, materials, shielding, and processing of nuclear fuels.

The engineer reader will probably find the chapters on reactor theory somewhat less rigorous than Glasstone and Edlund's "Nuclear Reactor Theory" and perhaps a bit slower reading than Soodak and Campbell's little monograph on "Elementary Pile Theory," but the necessary mathematics is threaded into a lucid textual discussion.—Dr. James B. Edson.

Sea Fights and Shipwrecks. By Hanson W. Baldwin. New York: Hanover House. 315 pp. $3.95.

THESE "true tales of the seven seas" are more fascinating and thrilling than any imagined stories both in the events and in the skilled writing of Hanson Baldwin. The eighteen separate tales cover stories of battles, mutinies, and wrecks over the past 150 years.

Though you may have read some of these yarns, you will be pleased to reread them in the light of the author's background notes and his effective story telling. Mr. Baldwin has scored a bull's-eye for historians in eliciting comment from Admiral Kincaid on the Battle for Leyte Gulf.

Following Baldwin's account, Admiral Kincaid, who commanded the invasion fleet off Leyte (7th Fleet), comments,

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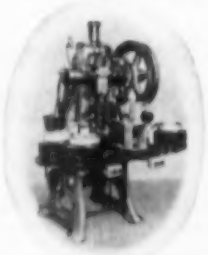
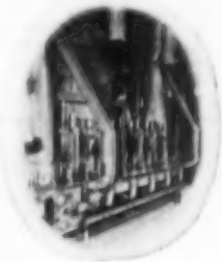


GLASSMAKING EQUIPMENT



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Book Reviews

after ten years of silence, on Admiral Halsey's foray to the north that left San Bernadino Straits uncovered. This allowed a heavy Japanese force to almost wipe out a light American unit of escort carriers and destroyers. Admiral Halsey's comments are also included. A highly interesting controversy without conclusion.

The author's background as a naval officer (USNA 1924), journalist, and renowned military writer never showed to better advantage. It is truly a book that is difficult to lay aside until finished.—J. M. P. Wright.

The Washington Papers—Basic Selections from the Public and Private Writings of George Washington. Edited by Saul K. Padover. New York: Harper & Brothers. 430 pp. $5.

IN this volume Mr. Padover has done considerably more than merely present a new and worthwhile arrangement of the papers of our first President. The *raison d'etre* of the work is exemplified in the short but cogent introduction, which the author terms "A Political Portrait and a Reappraisal."

This, as well as the selection of the writings, is aimed at explaining Washington's thoughts and hopes as the farmer, the homesick and tired family man, and the humble Christian citizen, rather than simply the great leader (so often dehumanized and difficult to understand).

The writings are arranged by subject rather than by strict chronology. Though state papers are not neglected, most of them are chosen to show the human personality behind the great events of Washington's life. Most readers will agree that few single-volume works succeed in doing this so well.—F. W. Foster Gleason.

The Rocket Pioneers. By Beryl Williams and Samuel Epstein. New York: Julian Messner, Inc. 241 pp. $3.75.

A VERY complete history of rocketry from the early experiments of William Congreve, through the dreams of Jules Verne and the theories of Ziolkovsky, who had the correct information but who never made a rocket, down to modern times. The experiments of Dr. Robert H. Goddard in the United States and Dr. Hermann Oberth in Germany, concurrent and independent, are treated fully in separate chapters.

The German Rocket Society and its American counterpart and their early experiments in the face of local opposition and paucity of funds contributed more to rocket development than will ever be credited. The Peënemunde story is briefly told, confirming information which is cov-

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Book Reviews

ered in detail elsewhere. It closes with a forecast of the future.

This is an exciting story, well told, much of it for the first time, and one which rocket fans must read.—T. K. VINCENT.

Caves of Biak—An American Officer's Experiences in the Southwest Pacific. By Harold Riegelman. New York: The Dial Press. 278 pp. $4.

VERY little has been written, at least in a popular vein, about chemical warfare in World War II until now. Colonel Riegelman, Chemical Officer of the I Corps in four Pacific campaigns, here gives his personal account of the war and sheds light on the activities of the Chemical Corps in the Southwest Pacific.

Jungle warfare required special tactical employment of flame throwers, incendiaries, and mortars. Starting with the early operations at Buna and ending with the Philippine campaign, the book describes the various attack techniques and how they were developed. The methods devised for reducing cave networks on the island of Biak are of special interest.

Any one, in any branch of the service, who traveled the route from Australia to the Philippines will find the author's stories of the people and places of that area highly reminescent.—R. J. WARFEL.

Atomic Energy Guide Book. Edited by Walter A. Shead. Washington: Atomic Energy Guideletter. 96 pp. $7.50.

HERE is a handy pamphlet and useful reference book for those who know their way about the atomic-energy field or who are interested in expanding their energies into nuclear matters.

The pamphlet gives information on such points as: how to enter atomic-energy business, uses of radioisotopes, explanation of the necessary clearances, and future expectations of commercial applications in the atomic-energy field.

Also included are useful directories of organizations and corporations presently engaged in nuclear matters, listed by States; a list of the manufacturers of atomic instruments; and the composition of various advisory citizens' committees. —J. M. P. WRIGHT.

Highway to the North. By Frank Illingworth. New York: Philosophical Library. 293 pp. $7.50.

THE author, an English writer, gives an interesting account of the people who travel the Alaskan Highway as a vocation and those who live along its 1,500 miles. The incidents are interesting and the toughness that is often associated with stories of the far north is pretty well disabused. (*Continued on p. 294*)

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Book Reviews

The kindheartedness of the people, their concern for each other's welfare, and the honesty which they apply to their dealings, gives a new picture of our frontier on the north.

With the emphasis currently being placed on radar networks and other defenses to the north, this account of a vital link in the communications system to that all-important region should be of vital interest to all.—T. K. VINCENT.

BOOKS RECEIVED

Civil War on the Western Border—1854-1865. By Jay Monaghan. Boston: Little, Brown & Company. 454 pp. $6.

Decisive Battles of the Civil War. By Col. Joseph B. Mitchell. New York: G. P. Putnam's Sons. 226 pp. $4.

Destruction and Reconstruction. Personal Experiences of the Late War. By Lieut. Gen. Richard Taylor, Confederate Army. Edited by Richard B. Harwell. New York: Longmans, Green. 380 pp. $7.50.

Dictionary of Mechanical Engineering Terms. Seventh Edition. Originally compiled by J. G. Horner. Revised and enlarged by Staton Abbey. New York: Philosophical Library. 417 pp. $6.50.

First Winchester, The. By John E. Parsons. New York: William Morrow and Company. 207 pp. $5.

Hannibal of Carthage. By Mary Dolan. New York: The Macmillan Company. 407 pp. $3.75.

Introduction to the Theory of Aëroelasticity, An. By Y. C. Fung. New York: John Wiley & Sons, Inc. 490 pp. $10.50.

Laplace Transforms for Electrical Engineers. By B. J. Starkey. New York: Philosophical Library. 279 pp. $10.

Nuclear and Radiochemistry. By Gerhart Friedlander and Joseph W. Kennedy. New York: John Wiley & Sons, Inc. 408 pp. $7.50.

Principles of Mass and Flow Production. By Frank G. Woollard. New York: Philosophical Library. 195 pp. $7.50.

Sound Barrier. By Neville Duke. New York: Philosophical Library. 129 pp. $4.75.

Symposium on Effect of Cyclic Heating and Stressing on Metals at Elevated Temperatures. Presented at the 57th Annual Meeting, American Society for Testing Materials, June 17, 1954. Philadelphia: American Society for Testing Materials. 184 pp. $3.

Web of Victory, The. Grant at Vicksburg. By Earl Schenck Miers. New York: Alfred A. Knopf. 320 pp. $5.

Your First Boat. How to choose it, how to use it. By David Klein. New York: Wilfred Funk, Inc. 216 pp. $2.95.

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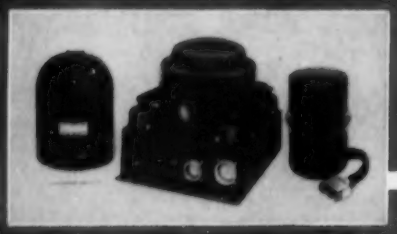

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GPL — GENERAL PRECISION LABORATORY INCORPORATED—PLEASANTVILLE, N. Y.

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LOW COST LIVING INDEX

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MISSILES IN PERSPECTIVE

The design and building of guided missiles requires a rare combination of talents—each in proper perspective.

Fairchild's Guided Missiles Division, one of the principal producers of guided missiles, is an organization which has this perspective. Its engineering teams are skilled in the fields of electronics and aeronautics—and in the required propulsion systems. Its production team has built, in substantial volume, *several* fundamentally different missiles.

These "teams" are directed by a management which has broad knowledge of missile requirements—and are supported by a facility built specifically for work on guided missiles.

ENGINE AND AIRPLANE CORPORATION

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Guided Missiles Division

WYANDANCH, N. Y.

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Aircraft Division, Hagerstown, Md.
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Speed Control Division, St. Augustine, Fla.
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Eastern Tool & Mfg. Co.

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Manufacturing for other manufacturers exclusively since 1910

Today LeTourneau Builds the CORPORAL LOADER

Another Machine for America's Defense
Powered By LeTourneau Electric Wheels

Supersonic speed and terrific striking power are only two of the big advantages built into the Corporal Guided Missile Weapons System.

Key factor in making this sleek new missile a successful tactical support weapon is *ground mobility* – the prime function of the *LeTourneau Corporal Loader.*

This powerful vehicle picks up the missile in rear storage areas, carries it "piggy-back" over highway or battlefield terrain to any forward area launching site, and erects it on the missile launcher for firing.

All these functions are handled with the same positive system of electric driving power and electric control that is now being utilized on other LeTourneau machines for America's defense, as well as for exploration, logging, land clearing, and other heavy industries. Corporal Loaders are now being delivered to troops.

The engineering and manufacturing facilities of R. G. LeTourneau, Inc., are ready now to help solve *your* problem. The Corporal Loader is substantial evidence that it *CAN* be done . . . with LeTourneau.

These photos show how Corporal Loader handles missile for delivery to launching site. This machine was designed and built in conjunction with Firestone Tire & Rubber Co., producers of the Corporal Guided Missile.

R. G. LeTOURNEAU INC

General Offices: 26511 S. MacArthur, Longview, Texas

Cable Address: BOBLETORNO

COMMUNICATIONS

NEED FOR CIVIL DEFENSE

THE EDITOR.—Suppose an atomic bomb hits Springfield, Mass., a city of 150,000 people—kills half of them, leaves 75,000 wounded. Forget the dead ones temporarily. The big civil defense effort now seems to be toward evacuation. But does any one imagine the cars will escape? Let's be silly and imagine they *do* escape—who will drive them? Roads are ruined; where do they expect to go? What becomes of them when they get there? Who has beds or even blankets? Who has food? What about sanitary facilities? Doctors? Splints? Remedies for burns? First aid?

I was the first Civil Defense director in Southern Berkshire County, Mass. I pleaded with a typical small-town government for a year or more—finally became disgusted and resigned. A complete organization of auxiliary police—firemen, wardens, first aid, communications, transportation, etc., resigned with me. Two others have quit since—one was a Congressional Medal of Honor holder.

Our government leaders are wasting priceless time throwing rocks at the moon. The money the United States has wasted on India, France, and others since 1952 would have done a job. But no politician will ever do it.

The job is not only not yet started—none of the brass seems to know what the job actually means or how to do it.

To be constructive, the Ground Observer Corps comes first. Put them back in Civil Defense where they belong. Make it possible for the *local* (not State) director to request one hour a week from each of the men in the Reserve and National Guard for duty at the observation post, and give him credit for an hour's training. It will do him more good than an hour of "squads east and west" under some top sergeant. And you will get the observers. You don't get them now.

If it is insisted that Ground Observer Corps must be a function of the Air Force, for heaven's sake get enough men on the job to handle it. One sergeant has the western half of this State to organize, is doing the best he can, and isn't scratching the surface.

Next, get some one in uniform—not a youngster—who knows what it is all about, who can *sell* the idea, to arrange meetings with the selectmen in the towns of, say, up to 10,000, and lay the law down to them. This isn't a "please mister" job. This is a *"must do."*

Make a housing directory of beds and

Producing small, sensitive electrical "nerves", or constructing great penetrating radar "eyes" . . . each demands advanced technology. And these are but two of the *hundreds* of complex tasks the AMF organization performs every day.

The highly specialized yet widely diversified activities of some 35 engineering and production facilities provide AMF with a wealth of experience that covers nearly every field of industry. And it is immediately available to *you*.

Call upon AMF with your problem. See for yourself why this all-around experience in answering the needs of government and industry alike has made AMF the "can do" company.

AMF HAS EXPERIENCE YOU CAN USE!

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and receive as an award Series I of American Ordnance Association Prints.

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Here are the names and addresses of friends I think should belong to the Ordnance Association. Please send to each person listed, who is not already a member, a special membership invitation telling him about the aims, purposes, and services of the A.O.A.

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Please print *your* name and address here so that we may mention your name, and also give you credit for the memberships obtained:

_____ *Your Name*

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Return to:

AMERICAN ORDNANCE ASSOCIATION
708 Mills Building • Washington 6, D. C.

Communications

halls with all essential data; have it mimeographed at the high school commercial class, and have it kept up to date.

Keep the local fire and police departments out of the picture. They will have plenty to do without becoming involved in the Civil Defense organization.

Get some of your local carpenters to make house-to-house calls, perhaps one a day, and advise the owners what to do for a "lean-to" shelter in the cellar and how to stock it.

Get the program out of the hands of the big shots. The local people can and will do it if the local authorities are impressed with the fact that it has to be done. It cannot be done by some political friend of somebody who can pass out a $15,000 appointment.

LIEUT. COL. W. H. WEINGAR
East Lee, Mass.

PEACETIME PREPAREDNESS

THE EDITOR.—With business booming and the cold war being eased off, there is a very real danger today that we may be lulled into a false sense of security regarding our national defense. We were woefully unprepared for World Wars I and II, and even the Korean campaign caught us off base in many respects.

It is to be hoped that the American Ordnance Association will be able to get across to industry and to all citizens the fact that preparedness is possible *only in peacetime*, and that sufficient preparedness is a real guarantee of peace.

E. J. ROGERS
Baltimore, Md.

FOR INTERNAL STRENGTH

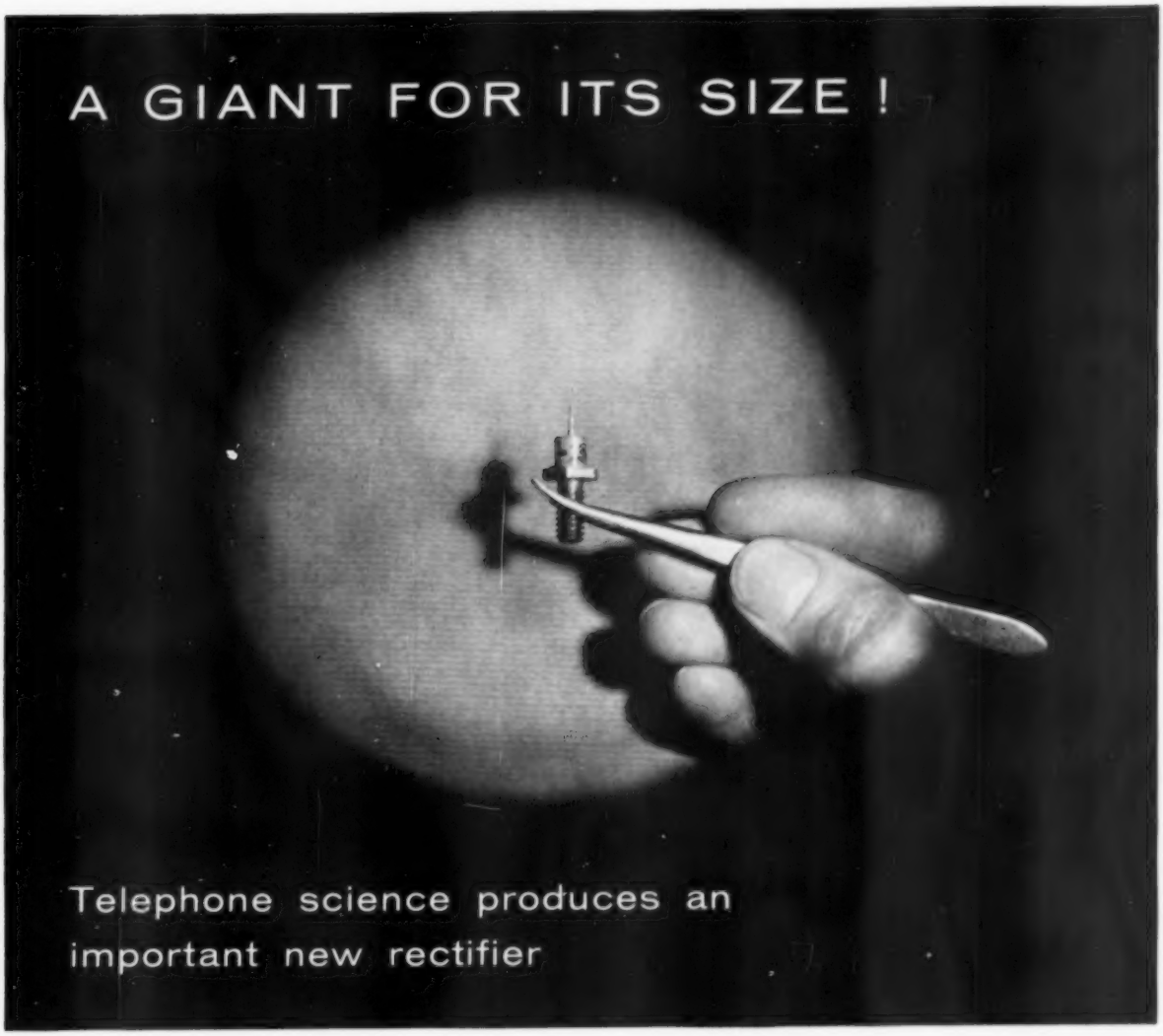
THE EDITOR.— I have been of the firm opinion that if there is a World War III it well may not be the "war to end all wars," but it certainly will be the last war modern man as we know him will participate in for a long, long time to come. Therefore it becomes of the utmost necessity to prevent it at all costs.

In order to do this we must, first and foremost, remain strong internally, for corruption within is the surest way for any country to collapse. Internal strength and the combined effort of a country's people are the very foundations of that country.

Secondly, and perhaps more important now than before, is national preparedness. In the next war we won't have any time cushion other than a few hours. Thus military mobilization and individual preparedness are the secret weapons the threatening enemy is deathly afraid of.

RONALD DELANEY
Cambridge, Mass.

A GIANT FOR ITS SIZE!



Telephone science produces an important new rectifier

At Bell Laboratories one line of research is often fruitful in many fields. Latest example is the silicon power rectifier shown above.

Product of original work with semiconductors—which earlier created the transistor and the Bell Solar Battery—the new rectifier greatly reduces the size of equipment needed to produce large direct currents. It is much smaller than a tube rectifier of equal performance and it does not require the bulky cooling equipment of other metallic rectifiers.

In the Bell System the new rectifier will supply direct current more economically for telephone calls. It can also be adapted to important uses in television, computers, industrial machines, and military equipment. Thus, Bell Telephone Laboratories research continues to improve telephony—while it helps other fields vital to the nation.

Above, new rectifier (held in pliers) is contrasted with comparable tube rectifier and its filament transformer, rear. Mounted on a cooling plate, lower center, the new rectifier can easily supply 10 amperes of direct current at 100 volts, that is 1000 watts—enough to power 350 telephones.

BELL TELEPHONE LABORATORIES

IMPROVING TELEPHONE SERVICE FOR AMERICA PROVIDES
CAREERS FOR CREATIVE MEN IN SCIENTIFIC AND TECHNICAL FIELDS

New higher Guarantees on

KAISER ALUMINUM STANDARD HAND FORGINGS
GUARANTEED MINIMUM MECHANICAL PROPERTIES FOR 2014-T6

Class	Cross Sectional Area in Sq. In.	Tensile Strength, 1000 PSI			Yield Strength, 1000 PSI			% Elongation in 2" or 4D*		
		Longitudinal	Long Trans.	Short Trans.	Longitudinal	Long Trans.	Short Trans.	Longitudinal	Long Trans.	Short Trans.
1.	16 and under Length up to 3 times width	65	63	62	55	55	55	10.0	6.0	4.0
2.	16 and under Length over 3 times width	65	63	62	55	55	55	10.0	5.0	3.0
3.	Over 16 to 36 incl. Length up to 3 times width	65	63	62	53	53	53	9.0	5.0	3.0
4.	Over 16 to 36 incl. Length over 3 times width	63	63	62	53	53	53	9.0	3.0	2.0
5.	Over 36 to 144 incl. Length up to 3 times width	62	59	59	53	52	52	7.0	3.0	2.0
6.	Over 36 to 144 incl. Length over 3 times width	62	59	59	53	52	52	7.0	2.5	2.0
7.	Over 144 to 256 incl. Length up to 3 times width	60	58	55	52	50	50	5.0	2.0	2.0
8.	Over 144 to 256 incl. Length over 3 times width	60	58	55	52	50	50	5.0	2.0	2.0

*The elongation requirement applies only to test specimens having a gage length diameter not less than 0.25".

SPECIAL PRODUCT KAISER ALUMINUM HAND FORGINGS
GUARANTEED MINIMUM MECHANICAL PROPERTIES FOR 2014-T6

Class	Cross Sectional Area in Sq. In.	Tensile Strength, 1000 PSI			Yield Strength, 1000 PSI			% Elongation in 2" or 4D*		
		Longitudinal	Long Trans.	Short Trans.	Longitudinal	Long Trans.	Short Trans.	Longitudinal	Long Trans.	Short Trans.
1.	16 and under Length up to 3 times width	65	65	65	55	55	55	10.0	6.0	6.0
2.	16 and under Length over 3 times width	65	65	65	55	55	55	10.0	6.0	6.0
3.	Over 16 to 36 incl. Length up to 3 times width	65	65	63	55	55	55	9.0	5.0	5.0
4.	Over 16 to 36 incl. Length over 3 times width	65	65	63	55	55	55	9.0	5.0	5.0
5.	Over 36 to 144 incl. Length up to 3 times width	64	64	61	53	53	53	7.0	4.0	4.0
6.	Over 36 to 144 incl. Length over 3 times width	64	64	61	53	53	53	7.0	4.0	3.0
7.	Over 144 to 256 incl. Length up to 3 times width	61	60	59	52	51	51	5.0	4.0	3.0
8.	Over 144 to 256 incl. Length over 3 times width	61	60	59	52	51	51	5.0	4.0	3.0

*The elongation requirement applies only to test specimens having a gage length diameter not less than 0.25".

Kaiser Aluminum hand forgings!

As a result of high priority development, Kaiser Aluminum can now supply you with Standard hand forgings of *guaranteed minimum mechanical properties in many cases exceeding AMS and Federal specifications!*

Improved casting techniques developed by Kaiser Aluminum result in a high degree of forging stock soundness permitting the improved properties. These techniques include new degassing and metal handling methods at the remelt stage. Ingots are consistently free of gas porosity and substantially free from inclusions. All Kaiser Aluminum hand forgings meet or exceed established industry standards for ultrasonic soundness.

Now—new "Special Product" group offers highest property values and quality available in the industry today!

By applying new forging techniques to the improved quality Kaiser Aluminum forging stock a new group of hand forgings —called "Special Product"—has been developed.

"Special Product" hand forgings have guaranteed minimum mechanical properties significantly higher than the improved Kaiser Aluminum "Standard" group. Of special interest to aircraft designers are the superior short transverse elongation values for *all* classes of this product in both 2014-T6 and 7075-T6 alloys. By offering hand forgings of this new, high quality, Kaiser Aluminum has achieved a standard long needed but not previously available to the aircraft industry.

Kaiser Aluminum hand forgings are now available in sizes up to 1200 pounds in a wide variety of shapes, with grain flow direction as specified by the customer.

For complete information, contact any Kaiser Aluminum sales office listed in your telephone directory. Kaiser Aluminum & Chemical Sales, Inc. *General Sales Office*, Palmolive Bldg., Chicago 11, Illinois; *Executive Office*, Kaiser Bldg., Oakland 12, California.

Send for informative folder listing complete specifications for Kaiser Aluminum standard and "Special Product" hand forgings.

For the new standard in hand forgings . . .

think of Kaiser Aluminum

KAISER ALUMINUM STANDARD HAND FORGINGS
GUARANTEED MINIMUM MECHANICAL PROPERTIES FOR 7075-T6

Class	Cross Sectional Area in Sq. In.	Tensile Strength 1000 PSI			Yield Strength 1000 PSI			% Elongation in 2" or 4D*		
		Longitudinal	Long Trans.	Short Trans.	Longitudinal	Long Trans.	Short Trans.	Longitudinal	Long Trans.	Short Trans.
1.	16 and under Length up to 3 times width	75	75	72	64	63	63	9.0	4.0	2.0
2.	16 and under Length over 3 times width	75	73	70	63	61	61	9.0	4.0	2.0
3.	Over 16 to 36 incl. Length up to 3 times width	73	71	68	61	60	60	7.0	3.0	2.0
4.	Over 16 to 36 incl. Length over 3 times width	73	71	68	60	59	59	7.0	3.0	2.0
5.	Over 36 to 144 incl. Length up to 3 times width	71	69	66	60	58	58	4.0	2.0	1.0
6.	Over 36 to 144 incl. Length over 3 times width	71	69	66	59	57	57	4.0	2.0	1.0
7.	Over 144 to 256 incl. Length up to 3 times width	70	67	64	58	56	56	4.0	2.0	1.0
8.	Over 144 to 256 incl. Length over 3 times width	70	67	64	58	56	56	4.0	2.0	1.0

*The elongation requirement applies only to test specimens having a gage length diameter not less than 0.25".

SPECIAL PRODUCT KAISER ALUMINUM HAND FORGINGS
GUARANTEED MINIMUM MECHANICAL PROPERTIES FOR 7075-T6

Class	Cross Sectional Area in Sq. In.	Tensile Strength 1000 PSI			Yield Strength 1000 PSI			% Elongation in 2" or 4D*		
		Longitudinal	Long Trans.	Short Trans.	Longitudinal	Long Trans.	Short Trans.	Longitudinal	Long Trans.	Short Trans.
1.	16 and under Length up to 3 times width	75	75	72	65	65	63	10.0	7.0	6.0
2.	16 and under Length over 3 times width	75	75	72	65	65	62	10.0	6.0	5.0
3.	Over 16 to 36 incl. Length up to 3 times width	75	74	70	63	62	60	8.0	6.0	5.0
4.	Over 16 to 36 incl. Length over 3 times width	75	74	70	63	62	60	8.0	5.0	4.0
5.	Over 36 to 144 incl. Length up to 3 times width	74	72	68	61	60	59	6.0	4.0	3.0
6.	Over 36 to 144 incl. Length over 3 times width	74	72	68	60	59	58	6.0	4.0	3.0
7.	Over 144 to 256 incl. Length up to 3 times width	71	69	66	59	57	56	5.0	4.0	3.0
8.	Over 144 to 256 incl. Length over 3 times width	71	69	66	58	57	56	5.0	3.0	2.0

*The elongation requirement applies only to test specimens having a gage length diameter not less than 0.25".

NOW! interchangeable parts

in two famous South Wind heaters...

CUT ORDNANCE CORPS HEATING COSTS

...reduce parts inventory 50%!

Ordnance Corps Research and Development and South Wind have worked closely together in developing and testing vehicle heaters 1030D and 1060D. Now these heaters, besides meeting rigid military requirements, have interchangeable service parts that *reduce Ordnance Corps costs, cut parts inventory in half!*

Two Units—Two Output Capacities—Same Parts!

By stocking parts for one heater, you automatically stock parts for the other . . . cut part costs . . . reduce handling and stock control problems. It adds up to greater economy in vehicle heating. It's available to you now from South Wind!

Outstanding developments like this are the result of careful planning, expert engineering and precision manufacturing. Specify South Wind—maker of the famous heaters that cut costs and standardize parts for the Ordnance Corps! Application of these same South Wind skills can help solve *your* particular vehicle heating problem.

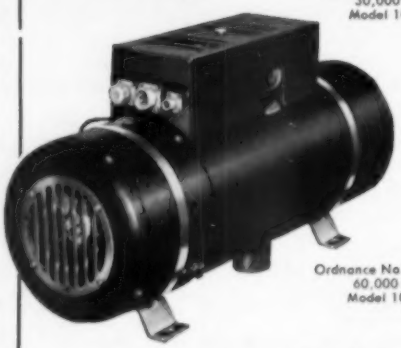
All three basic heating needs for vehicles —in ONE heater!

1. **Engine Pre-heating.** Makes starting easier, faster. Floods engine components – battery, crankcase, carburetor – with fresh, heated air.

2. **Personnel Heating.** Keeps personnel comfortable and at peak efficiency with fresh hot air, independent of engine heat.

3. **Windshield Defrosting.** Assures clear vision, safer driving. Keeps windshield "frost-free."

Ordnance No. 8720193
30,000 BTU
Model 1030D



Ordnance No. 8720194
60,000 BTU
Model 1060D

There's a South Wind Heater for every heating need

Do you have a heating problem? Write today for the experienced counsel of South Wind field engineers on any problem in internal or external pre-heating or space heating. The wide range of South Wind Heaters includes 20,000 —30,000 — 60,000 — 100,000 — 200,000 and 600,000 BTU/hr. capacities. Write South Wind Division, Stewart-Warner Corporation, 1514 Dover Street, Indianapolis 7, Indiana.

South Wind

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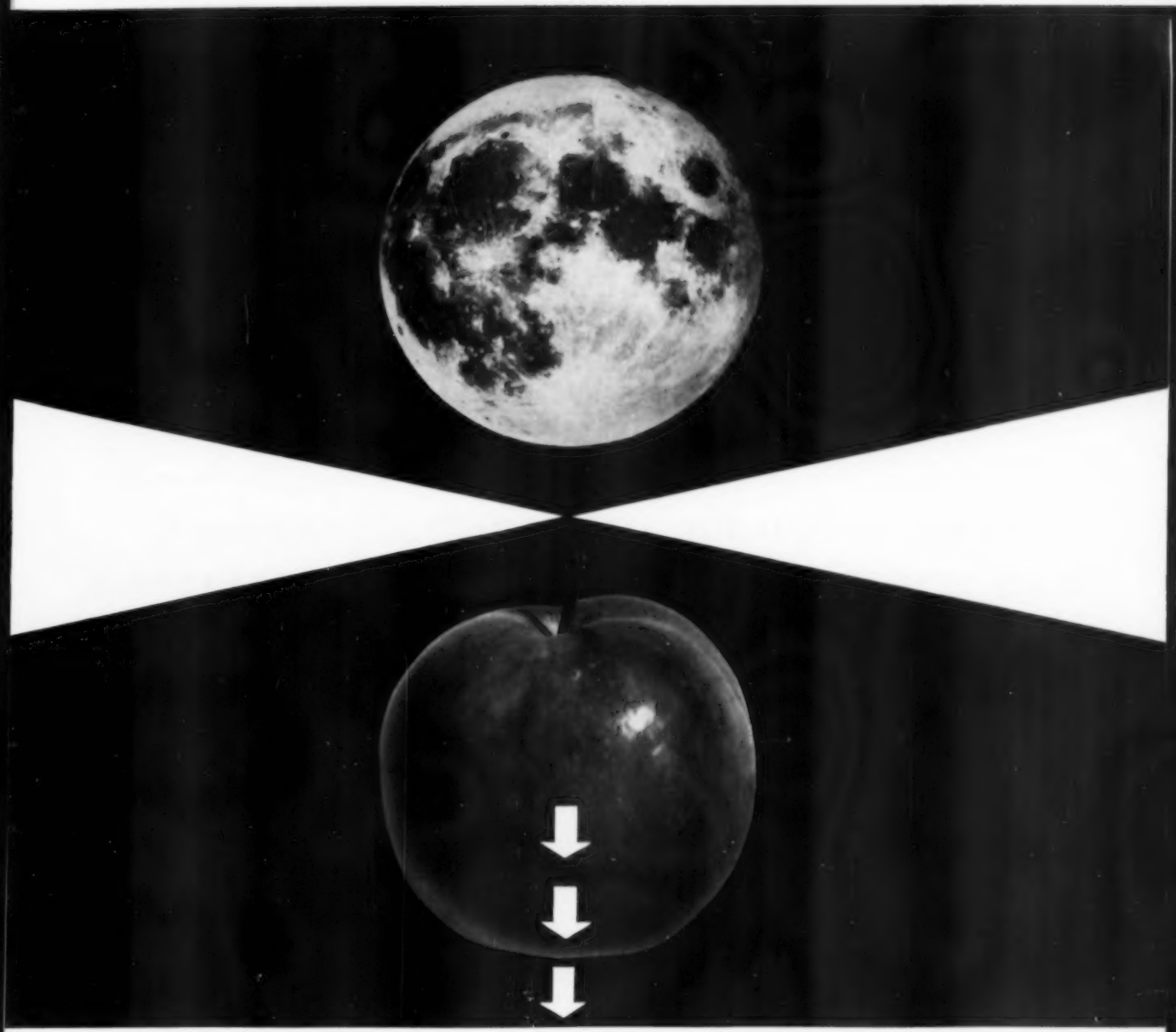
A PRODUCT OF SW STEWART-WARNER

Engine and Equipment Pre-heating
Windshield Defrosting
Personnel Heating



PROBLEM: GRAVITY

Interested in it? So are we!

For part of the work in advanced design at Martin includes an overall search into the basic laws of the universe – probing the unknown in every field that relates to airborne systems.

As a result of this far-reaching program of exploration – which includes the establishment of an independent laboratory for pure and advanced research – exciting new long-range developments have created exceptional opportunities at Martin on projects of the highest priority and importance.

Opportunities such as these are an engineer's dream!... If you are one of the many creative engineers who are lost in large organizations, anchored to static, non-creative jobs – ceiling zero, visibility zero – you'd do well to look into the Martin story.

MARTIN
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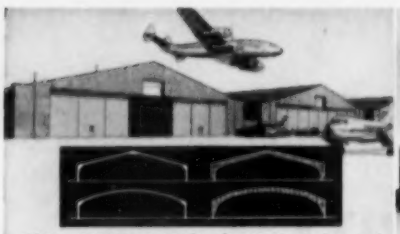
LURIA STANDARDIZATION PROVIDES THE FAST, EASY, ECONOMICAL SOLUTION TO AIRPORT EXPANSION

Why do Luria steel structures fill the widest variety of airport needs? Because the Luria System of Standardization provides the *adaptability, flexibility*—yes, and even the *permanence*—that formerly could be found only in *custom-built* units. *And this is achieved without sacrificing the speed and economies of standardization.*

During the last ten years, nearly 500 Luria aircraft installations have been made. The United States Air Force has standardized on 14 Luria designs . . . and uses a wide variety of other Luria hangars. At Lockheed Aircraft, Luria structures cover over a million square feet. Among the hundreds of other Luria installations are hangars and buildings for the airfields of Turkey, Iran and Argentina . . . for many air lines including Pan American, United, American, Eastern, Northwest and Capital . . . and for many airports including New York International, Detroit Wayne Major, Springfield, Illinois and Westchester County, New York.

A PARTIAL SHOWING OF STRUCTURES FOR EVERY TYPE OF MILITARY AND COMMERCIAL AVIATION



STANDARDIZED HANGARS — both girder and truss types for commercial and military aircraft.

ALL-PURPOSE "WING" HANGAR accommodates one heavy aircraft or two medium aircraft.

DOUBLE CANTILEVER hangar for double-apron air traffic. Accommodates aircraft of all sizes.

AIRPORT TERMINAL shows how effectively Luria steel buildings can be adapted to airport needs.

STANDARDIZED MAINTENANCE SHELTER for heavy aircraft. Portable, enclosed, weather-proof.

- ☑ PERMANENT CONSTRUCTION
- ☑ MAXIMUM FLEXIBILITY
- ☑ HIGH SPEED ERECTION
- ☑ LOW COST MAINTENANCE
- ☑ GREATER AVAILABILITY

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The world's most powerful tractor _with Torqmatic Drive

TWIN POWER TRAINS—made possible by Allison TORQMATIC DRIVES—make Euclid's new TC-12 the world's most powerful crawler sold today.

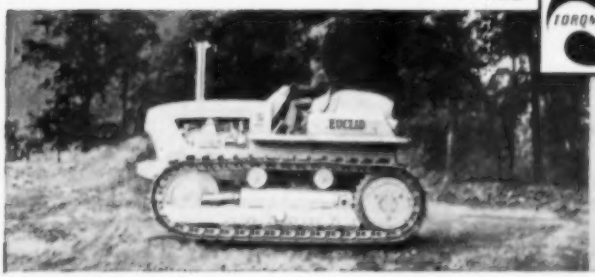
This twin-engine giant gets 388 horsepower from two GM Diesels—uses a pair of TORQMATIC Converter-Transmission teams to turn that power into more than 100,000 pounds drawbar pull and provide a smooth, steady flow of power for all job requirements.

But for all its power the TC-12 is easy to run for it has no master clutch.

The driver changes speeds with finger-tip hydraulic control at full power, instantly shifts from forward to reverse, spins his tractor in its own length, maneuvers with no more than a twist of the wrist.

And he gets more work done per day because with a top speed of 730 feet a minute the TC-12 doesn't crawl—it really moves fast.

You can build or buy a better product by specifying TORQMATIC DRIVES for your hard-working gasoline- or Diesel-powered equipment. Ask your equipment dealer or manufacturer for more information or write direct to Allison Division of General Motors, Box 894W, Indianapolis 6, Indiana.



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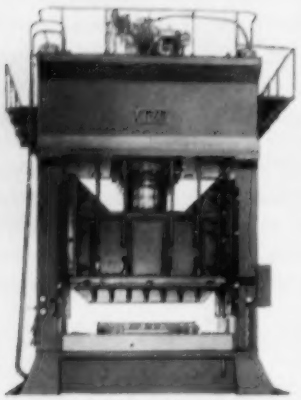
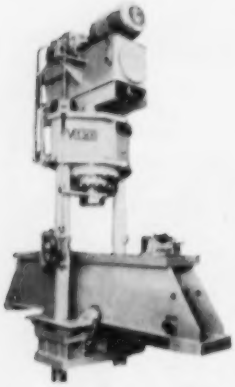
FROM TRADE Verson MARK
A COMPLETE RANGE OF HYDRAULIC PRESSES



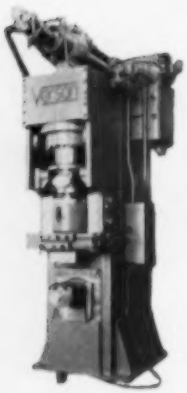
1200 ton straight side

750 ton post type

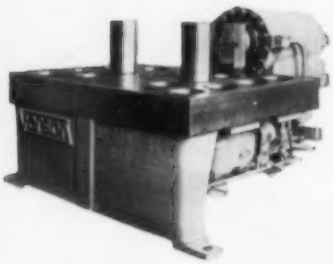
400 ton double action



400 ton straightening press



300 ton horn press



200 ton bending press

Write for your copy of the new Verson Hydraulic Press Catalog which contains detailed data on the entire Verson hydraulic line.

In the Verson line of hydraulic presses, there is a size and type to meet virtually every need from 75 tons up. In addition to the more common types illustrated above, Verson also manufactures such special models as gap type presses, bulldozers, hobbing presses, rubber pad cutting presses and pipe forming presses. If there is a question as to whether a mechanical type or a hydraulic type is best for your job, Verson, as a leading manufacturer of both types, is able to make unbiased recommendations.

Whatever your press problem, bring it to Verson and take advantage of our extensive know-how and experience.

A Verson Press for every job from 60 tons up.

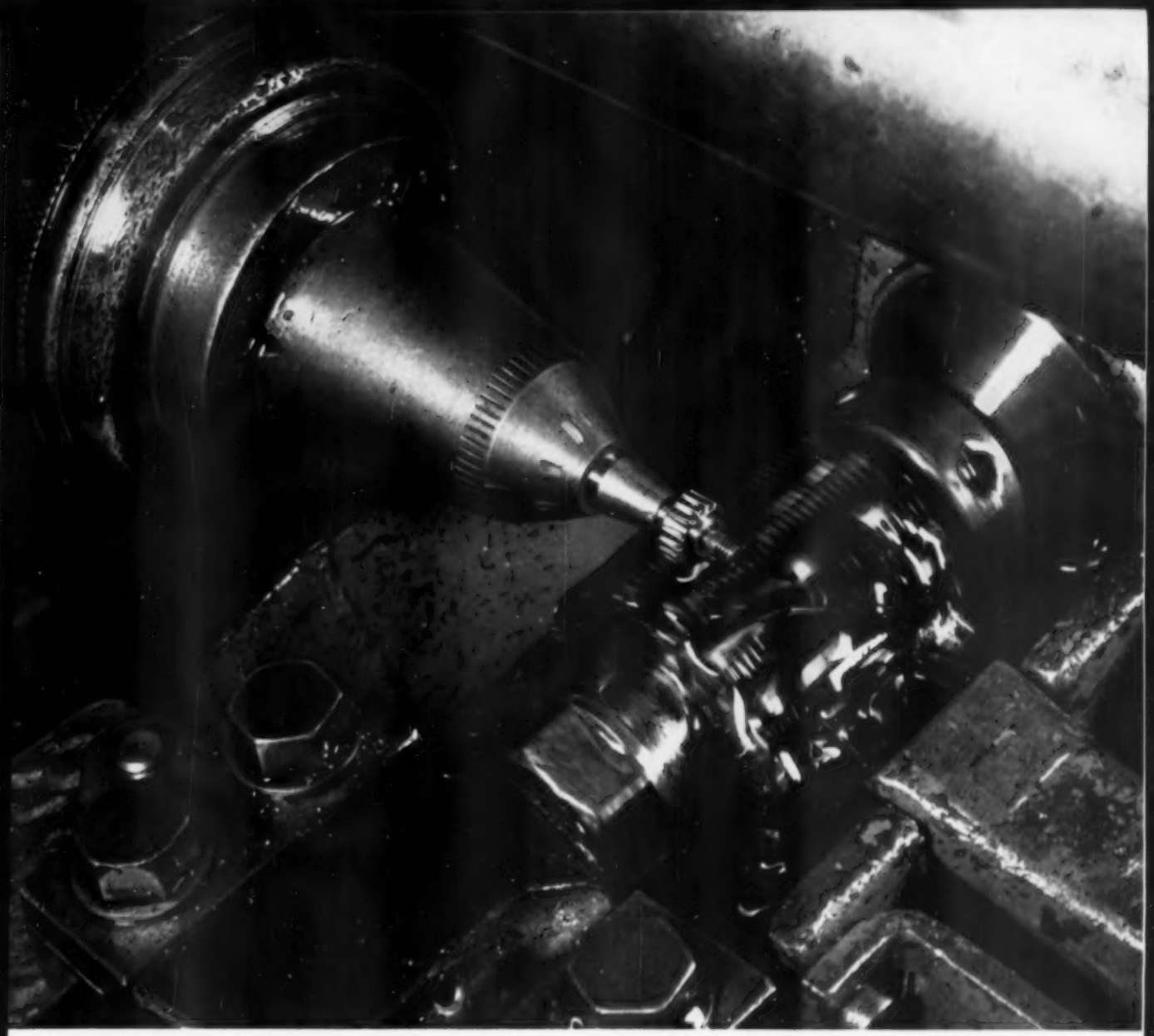
TRADE Verson MARK

ORIGINATORS AND PIONEERS OF ALLSTEEL STAMPING PRESS CONSTRUCTION

VERSON ALLSTEEL PRESS CO.

9351 S. KENWOOD AVENUE, CHICAGO 19, ILLINOIS • SO. LAMAR AT LEDBETTER DRIVE, DALLAS, TEXAS

MECHANICAL AND HYDRAULIC PRESSES AND PRESS BRAKES • TRANSMAT PRESSES • TOOLING • DIE CUSHIONS • VERSON-WHEELON HYDRAULIC PRESSES



THIS GEAR HOBBER maintains quantity output at a standard tolerance of .0002 inches (total composite error). Like much of the equipment at the Mechanical Division of General Mills, it was specially rebuilt in our plant to achieve higher standards of accuracy than those claimed by its manufacturer.

NEED PRECISION AND VOLUME?

Laboratory precision combined with quantity output—that's the rare combination you'll find at the Mechanical Division of General Mills. Superior equipment, experienced craftsmen, streamlined methods result in a fast, accurate job.

Whether you require a single gear or entire control systems for aircraft or missile guidance, we have the skills and facilities to handle the job perfectly from original design to field service.

WHAT'S YOUR PROBLEM? General Mills can help you with research, design, development, production engineering and precision manufacturing in connection with • bombing, navigation and missile control systems • industrial instrumentation and control • automation • specialized precision instrumentation • electro-mechanical computers • remotely-controlled manipulators • fine-particle technology • meteorological and high-altitude research.

NEW BOOKLET describes and illustrates the services available to you at the Mechanical Division. For your copy address Dept. O-2, Mechanical Division of General Mills, 1620 Central Avenue, Minneapolis 13, Minn.

Job opportunities available for creative engineers. Work closely with outstanding men on interesting projects.

MECHANICAL DIVISION OF General Mills, Inc.

Business tragedy . . . she just hung up on the firm's best customer!

It could happen to any secretary. The boss wandered off without telling her where. Then Mr. Big called. So the girl looked for her boss in three other offices, returning each time to report. Then, as she started her fourth scouting trip, she unthinkingly hung up the 'phone!

Not exactly a world-shaking catastrophe, but there ought to be some way of avoiding it—especially when you think that the party cut off might have been on the verge of okaying a really big deal.

Such a situation need never occur to *you*, if your business were located in a community using Stromberg-Carlson telephones, and you were leasing a wonderful new development which we call our "6K System."

This is an ingenious combination of electrical relays, a power supply and the telephone instrument shown at the left—a desk-type with six special keys on it. Anybody with such a 'phone can originate or answer "outside" calls, *hold* calls on any line, intercommunicate within the premises and even signal co-workers by buzzer.

The secretary above, for instance, would have answered the call from the customer on Line 1, *held* the call by pressing the Hold key, used the intercom facilities to call around the building and—when she finally located her man, he'd simply pick up the nearest telephone, press key number 1 and be automatically connected with his client.

We take this sort of pains to solve the little problems of business efficiency. We have often applied the same ingenuity to problems of Uncle Sam.

There is nothing finer than a

Stromberg-Carlson®

Radio, TV and High Fidelity Equipment

Telephones and Central Office XY® Dial Equipment

Sound and Public Address Systems

Electronic Products for our Armed Forces

STROMBERG-CARLSON COMPANY, ROCHESTER 3, N.Y. • A DIVISION OF GENERAL DYNAMICS CORPORATION

DOW

magnesium

airborne hangar for the Marine Corps

. . . made of Magnesium

The U.S. Marine Corps called for a very particular metal for the framework of a very unusual "flying hangar." This metal had to be:

- Light enough to be carried, completely assembled, by a helicopter.
- Strong enough to withstand the repeated takeoffs and landings.

Magnesium, with its high strength/weight ratio, was the answer. Matter of fact, magnesium is appearing in more applications every day where light weight and simplified design are important.

Follow the Marine Corps—take a new look at magnesium! Call your nearest Dow sales office for more information or write to THE DOW CHEMICAL COMPANY, Midland, Michigan, Dept. MA-313L-1.

you can depend on DOW MAGNESIUM DOW

TEMCO'S TEAM

Research
Development
Production

The TEMCO team, in its dual role as supplier to the Armed Forces and manufacturer of civilian goods, is equipped to serve the Department of Defense and American industry whenever technical skills are required. If you have a problem, let the TEMCO team go to work for you. An example of our ability to develope new equipment in answer to a specific problem is the miniature tape recorder pictured in the inset photograph.

This is the tape transport of a miniaturized magnetic tape recorder in the final development stage. When assembled the recorder occupies a space less than 3 inches in diameter and 6¾ inches in length. The tape recorder has been repeatedly subjected to 3000g initial acceleration while being launched from a smooth bore test vehicle.

For Complete Specific Details SEND FOR... TEMCO'S "NEW HORIZONS IN RESEARCH" BOOKLET

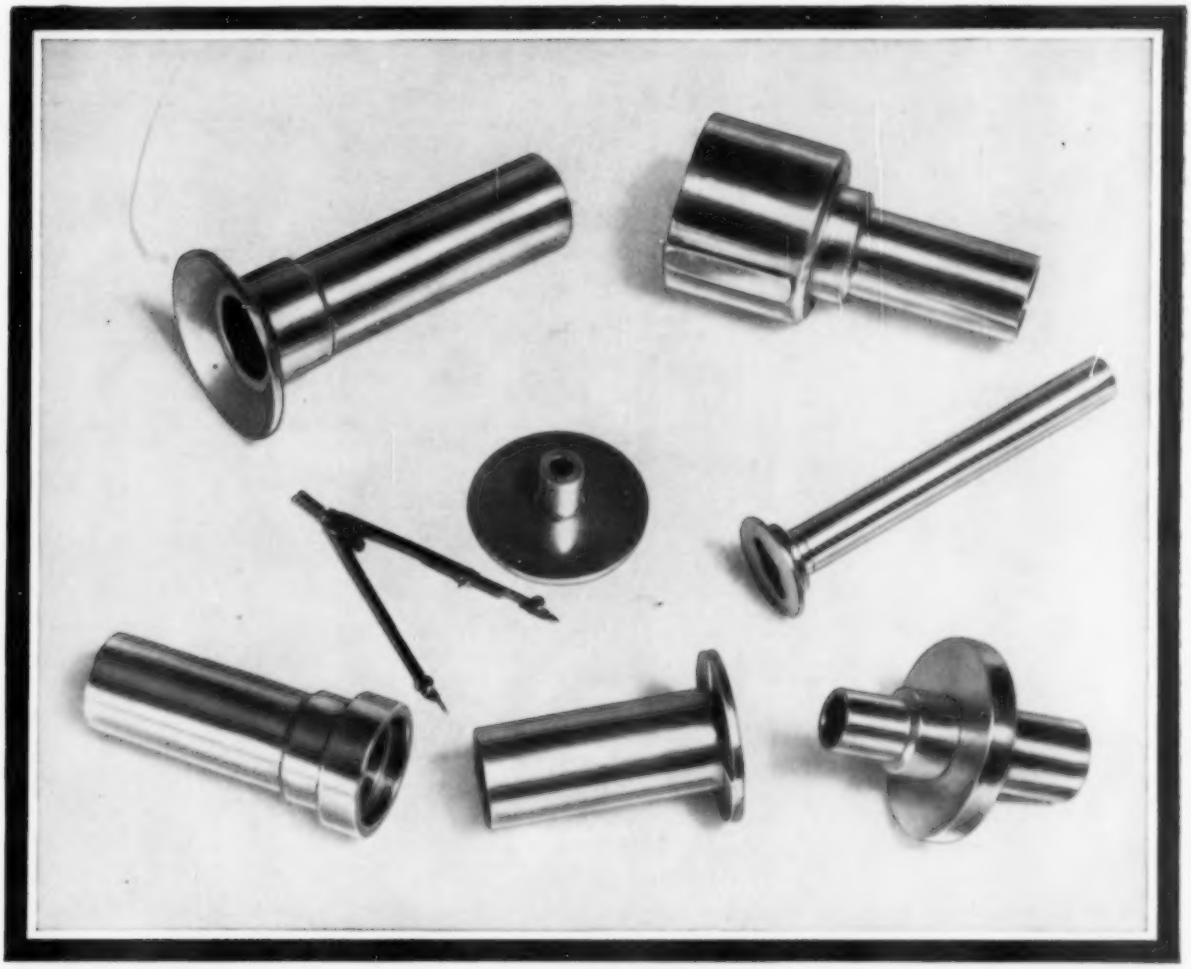
RESEARCH CAPABILITIES

- Miniaturization of Electronic and Mechanical Equipment
- Transistor Applications
- Telemetering
- Ballistic Testing
- High Speed Photography
- Instrumentation
- Control Systems
- Heat Transfer
- Communications
- Mechanical Design and Development
- Munitions and Weapons Development

TEMCO inc.

NASHVILLE 9, TENNESSEE

Inquiries are invited from Engineers, Physicists, and Mathematicians desiring positions with a progressive research organization.



PICK ANY ONE, ALCOA CAN IMPACT IT IN ONE PUNCH

In a single press stroke, Alcoa forms seamless tubular parts like these with diaphragms, flanges, shoulders and ribs. And for parts like these, impact extrusion is the only economical method of one-operation forming. Alcoa Impacts combine the advantages of an extruded side wall and a forged bottom to give you ultimate lightness and strength.

If you have confined your thinking of impact extrusions to tooth-paste tubes and condenser cans, see what is being done today at Alcoa's Impact plant. For instance, we make a variety of nonsymmetrical parts; use strong alloys; produce heavy sections and long, thin tubular parts.

Your local Alcoa sales engineer offers unbiased help in your design problems. His intimate knowledge of the impact process may effect substantial savings to you. He is listed under "Aluminum" in the classified phone book. Aluminum Company of America, 850-L Alcoa Building, Pittsburgh 19, Pennsylvania.

Your Guide to Aluminum Value

ALCOA ALUMINUM

Fasten Aluminum With Alcoa® Aluminum Fasteners

Alcoa Makes Impact Extrusions to Your Specifications

anti-aircraft fire control

. . . AND FORD INSTRUMENT COMPANY

In World War I, anti-aircraft fire against slow, low flying planes, could be managed by optical sighting and correcting from observed air bursts. Today's supersonic planes, flying at great altitudes must be tracked by radar and the guns directed by complex computers.

The Navy Bureau of Ordnance and Ford Instrument Company perfected the first successful naval anti-aircraft gun director (Mk 19) back in 1926 and Ford Instrument Company has been one of the outstanding leaders in this field ever since.

Precision equipment for the exacting problems of computers and controls for both the military and industry, has been the specialty of Ford Instrument Company since 1915.

Ever since Hannibal C. Ford built the first gunfire computers for the U. S. Navy forty years ago, Ford Instrument Company has been a leader in applying the science of automatic control to American defense and peacetime industry. For more information about Ford's products, services, and facilities, write for free illustrated brochure.

53

FORD INSTRUMENT COMPANY

DIVISION OF SPERRY RAND CORPORATION

31-10 Thomson Avenue, Long Island City 1, New York

ENGINEERS: FORD IS CONSTANTLY ADDING TO ITS STAFF OF ENGINEERS. IF YOU CAN QUALIFY, THERE MAY BE A POSITION FOR YOU.

helping hands . . . united yet diversified

Today, it takes more than a better mousetrap for the world to beat a well worn path leading to your door.

Today, it takes the helping hands of diversified industries united under one progressive management.

. . . A management that has the background to cut costs and step-up production, and at the same time insure quality leadership for each and every product.

. . . A management that utilizes the help of each division—in getting the best from all divisions.

. . . A management with an attitude that fosters new markets and improved products.

USI is such an organization—a dynamic group of divisions serving many industries where its products are accepted as the finest in the field. An organization that is noted for its ability to give a helping hand to any branch of industry.

If you would like specific information on the USI products that are serving with distinction in *your* field, we invite you to write today.

CLEARING MACHINE CORPORATION. Mechanical and hydraulic metal-forming presses and accessories. Plants at Chicago, Illinois, and Hamilton, Ohio.

CHICAGO STEEL TANK COMPANY. Steel tanks of all sizes for home and industry. Plant at Chicago, Illinois.

AXELSON MANUFACTURING COMPANY. Petroleum pumping equipment, milling machines, engine lathes, aircraft components. Plants at Los Angeles and Montebello, California, and St. Louis, Missouri.

CONDUIT FITTINGS CORPORATION. Small electrical parts and die-castings. Plant at Chicago, Illinois.

SOLAR-STURGES MANUFACTURING COMPANY. Dairy cans, waste receptacles, cookware. Plant at Melrose Park, Illinois.

ORDNANCE DIVISION. Modification and processing of armored vehicles of all types. Plant at Hegewisch, Illinois. Also operates ordnance plant at Rockford, Illinois.

KOPPEL INCORPORATED. Distributors of leading agricultural and industrial machinery and equipment in the Philippine Islands.

PRESSED STEEL CAR CO., DIV. Exporters of railway equipment and industrial equipment and machinery to all parts of the world.

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USI

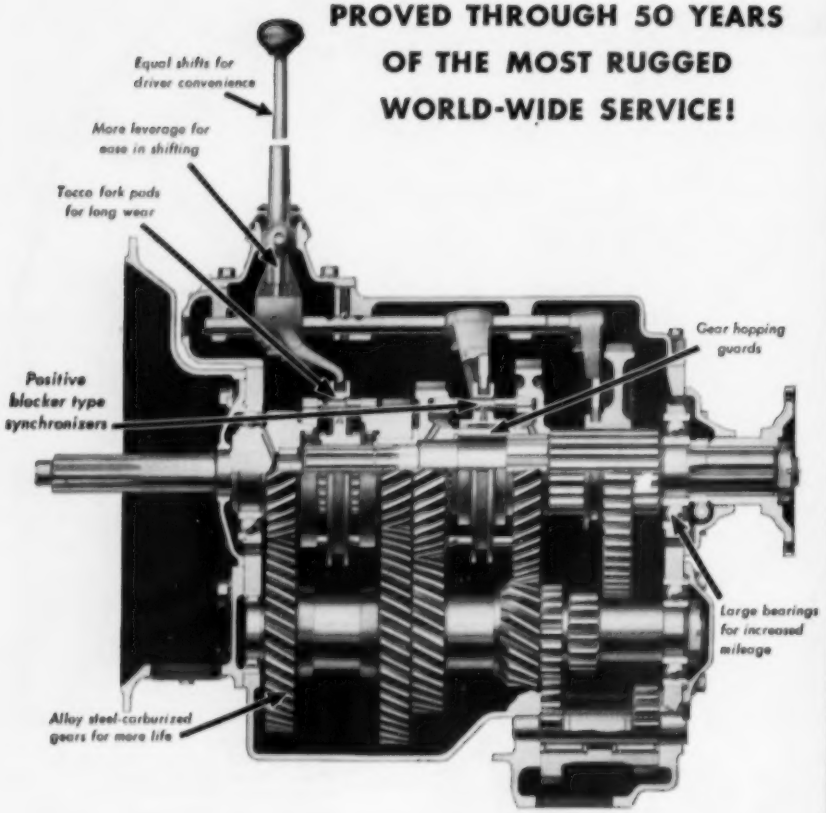
"A FAMILY OF MEN & MACHINES UNITED TO SERVE INDUSTRY BETTER"

Spicer BROWN LIPE

Fully Synchronized

TRANSMISSIONS

PROVED THROUGH 50 YEARS OF THE MOST RUGGED WORLD-WIDE SERVICE!


Equal shifts for driver convenience
More leverage for ease in shifting
Tocco fork pads for long wear
Gear hopping guards
Positive blocker type synchronizers
Large bearings for increased mileage
Alloy steel-carburized gears for more life

The *first* selective type transmission in automotive history was shipped from the Brown-Lipe factory to E. R. Thomas Motor Company in 1906. As standard equipment in the Thomas Flyers in 1908, a Brown-Lipe Transmission helped one of these famous cars win *First Place* in the only round-the-world automobile race ever held.

Today, the Spicer Brown-Lipe Fully Synchronized Transmission is still setting outstanding records for ruggedness, economy and ease of operation in hundreds of thousands of heavy-duty truck and bus installations.

Military and civilian service in all parts of the world have *tested and proved correct* the Spicer Fully Synchronized gear-shift principles illustrated here.

Ask Spicer engineers to demonstrate the many advantages of the Spicer Brown-Lipe Fully Synchronized Transmission to your heavy duty needs in any field.

The longest auto race that ever took place . . . round-the-world in 1908 . . . was won by a Thomas Flyer equipped with a Brown-Lipe Transmission

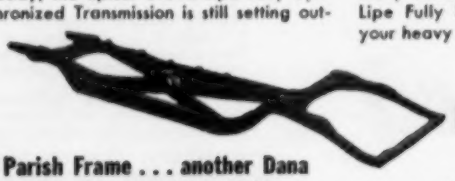
The race started in New York in February 1908, with 6 cars entered, and primitive road conditions were encountered right from the start.

In the race across the U.S. to Seattle, western gumbo and axle-deep water holes were conquered by unfailing Brown-Lipe transmission of power.

Shipped to Japan by boat, the sturdy Thomas Flyer once again started to blaze its own trails through roadless country.

Non-existent highways in Russia required travel for days at 10 miles per hour over ties of the Trans-Siberian Railroad.

After covering 13,000 land miles—8,000 in low gear—the race ended in Paris 170 days later with the Thomas Flyer as the winner!



—and a Parish Frame . . . another Dana product . . . assured an unyielding backbone of strength for the winning Thomas Flyer!

DANA CORPORATION
Toledo 1, Ohio

SPICER PRODUCTS: TRANSMISSIONS • UNIVERSAL JOINTS • PROPELLER SHAFTS • AXLES TORQUE CONVERTERS • GEAR BOXES • POWER TAKE-OFFS • POWER TAKE-OFF JOINTS • RAIL CAR DRIVES • RAILWAY GENERATOR DRIVES • STAMPINGS • SPICER AND AUBURN CLUTCHES • PARISH FRAMES

The day Zenith refused to fill thousands of orders

Back in early 1953, Zenith was about to market a new and revolutionary hearing aid which featured transistors instead of bulky vacuum tubes. These tiny transistors—the "powerhouses" of electronics—slashed battery operating costs, required only one battery instead of two, and promised a much longer life.

We ordered our transistors from a large electronics supplier and installed them in a pilot run of our tiny new hearing aids. Then, in line with our policy of *double testing* every Zenith product, both civilian and military, we sent the aids to our laboratory—"Phase One" in our testing procedure. They passed with flying colors.

Then, even though competitive models were now being offered for sale, we submitted our new hearing aids for *field and life* testing, "Phase Two" of the rigorous test series through which all new Zenith models must pass.

This field and life testing was done by a selected group of hard-of-hearing physicians, scientists and other qualified hearing aid users who tested the new product in everyday use, under every possible condition! Their reaction was so enthusiastic that we tooled up, built an inventory, and planned to hit the market on April 6, 1953.

Then it happened. The transistors in the new hearing aids began to *fail* due to a complication that could *only* be discovered by prolonged actual use!

This, at a moment when production lines were running at full speed . . . when a gigantic advertising program was ready to be launched . . . when dealers were shouting for shipments . . . when consumers by the thousands were begging for new hearing aids!

In the face of all this, we called the whole thing off.

We refused to fill thousands of orders that had already poured in. We refused to give our customers a hearing aid that might fail when it was needed most. We urged people to continue buying the reliable vacuum tube model until transistors were perfected.

And perfected they finally were. After again assembling the new transistor hearing aids . . . after again testing them in the laboratory and in the field, Zenith finally offered them to the public in November, 1953. At long last, here was a transistor hearing aid which would *not* fail those who depended upon it . . . a new, *quality* hearing aid which had finally earned the right to bear the Zenith insignia.

This story is just one more example of Zenith's insistence upon testing, re-testing, and absolute perfection. It is one reason why Zenith is called upon so frequently by the Government to turn out always-dependable weapons of defense. Our 36 years of specialization in radionics has created a Pledge of Quality which remains inviolate: *always the best of everything . . . in everything that Zenith makes.*

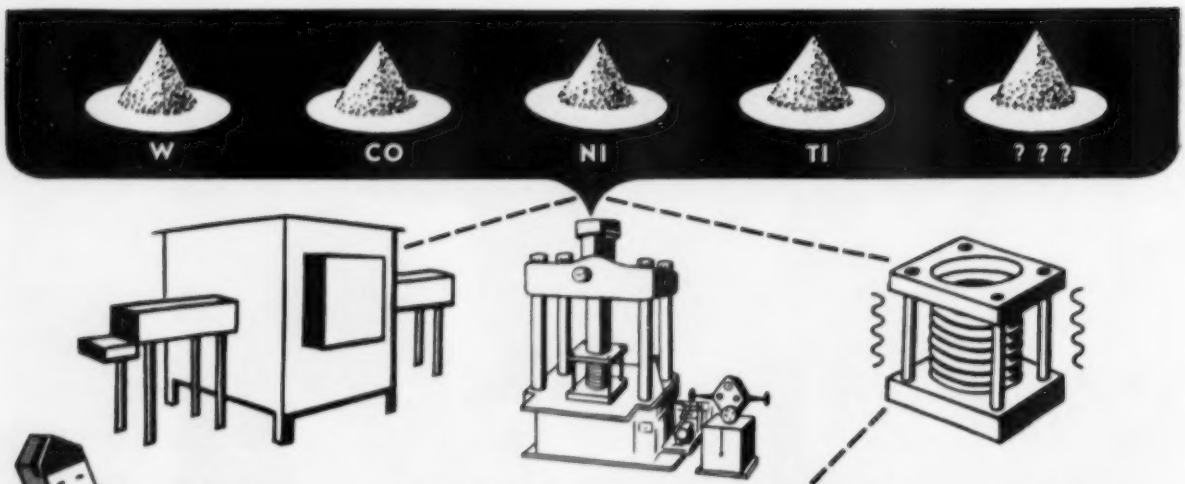
ZENITH

The royalty of TELEVISION and RADIO

ALSO MAKERS OF FINE HEARING AIDS

Zenith Radio Corporation • Chicago 39, Illinois

ZENITH, *backed by 36 years of specialization in radionics, serves America with a* **STRONGER DEFENSE AND A BETTER WAY OF LIVING**



Cold Press and Sinter or Hot Press or Vacuum Sinter!

25 Years of Powder Metallurgy EXPERIENCE FOR SALE!

THE PROBLEM — Industry and Government are engaged today in a gigantic effort to develop new alloys and stronger metals. The future security of America depends on the success of this program. Powder metallurgy, possessing unique advantages not common with any other process, can solve many of the tough metallurgical problems created by the jet age.

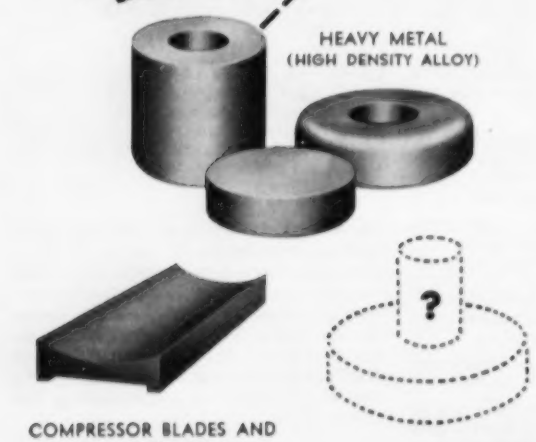
THE FACILITY — Metal Carbides, a pioneer in powder metallurgy, is well qualified by the experience of the past 25 years to help solve your particular problem. Our modern, well-equipped plants of over 100,000 sq. ft. are at your disposal, manned by skilled technicians and metallurgists capable of performing every technique known to powder metallurgy. Here are the facts:

THE PROCESS — Our equipment is varied and complete. Cold pressed and sintered parts can be processed in a vacuum or controlled atmosphere. Hot pressed parts can be produced up to 30" in diameter, up to 100" in length, and up to 5000 lbs. Other available processes include vacuum casting, centrifugal casting, hot forging and vacuum impregnation.

THE MATERIAL — Our experience covers the processing of carbides of tungsten, titanium, tantalum, molybdenum, chromium and columbium. Extensive experiments have also been conducted with various borides, silicides and oxides. Combinations of metals and ceramics have been developed which show great promise, and new possibilities seem unlimited.

THE ANSWER — Metal Carbides has found that by combining the best features of the above processes — with the right combination of metals and materials — totally new advantages result. Whether you require a structure that is porous, dense or tough — or a material that will withstand heat, corrosion or shock — let us put our experience to work helping you reach your objective! **Metal Carbides Corporation, Youngstown 7, Ohio.**

Send for new 84-page Catalog No. 55-G.



COMPRESSOR BLADES AND TURBINE BUCKETS FOR JET ENGINES

WIRE, WRITE or PHONE particulars of your problem or objective and we will advise promptly what our Powder Metallurgy technique can do for you.

METAL CARBIDES CORPORATION
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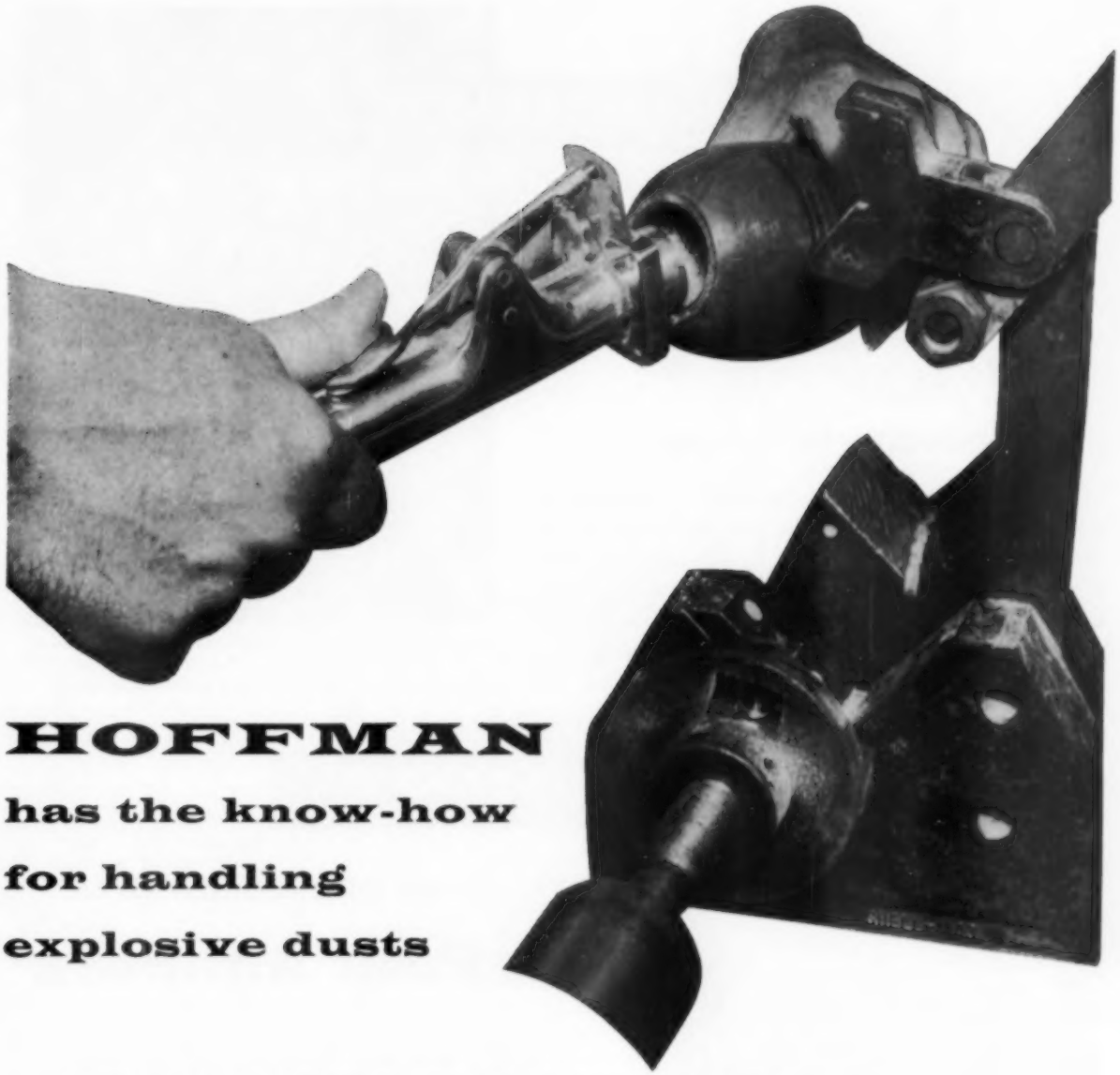
YOUNGSTOWN 7, OHIO

HOT PRESSED AND SINTERED CARBIDES · VACUUM METALS
HEAVY METAL · CERMETS · HIGH TEMPERATURE ALLOYS
OVER 25 YEARS' EXPERIENCE IN TUNGSTEN CARBIDE METALLURGY



HOFFMAN

has the know-how for handling explosive dusts

Since 1936, when Hoffman engineered the pioneer application of vacuum cleaning to shell loading operations, problems in conveying, collecting and other pneumatic handling of explosives have received specialized solutions from U.S. Hoffman engineers. Safe to say that Hoffman systems today are protecting the principal producing plants.

Stationary cleaning and conveying systems designed by Hoffman incorporate the rugged, dependable performance of the Hoffman multistage centrifugal exhauster-blower – Hoffman primary and secondary separators – and a unique series of design and positive-control features – all proven to provide safe, uninterrupted operation.

Hoffman design and engineering ability, of the level that develops explosives clean-up and collection systems, is reflected in pneumatic applications of many kinds; in industrial filtration operations; in improved procedures for metal cleaning and pre-coating; in the solving of many production problems.

Hoffman engineers will be glad to work with you.

Please write, or call: *ORDNANCE EQUIPMENT DIVISION*

U.S. HOFFMAN MACHINERY CORPORATION DEPT. ORD, 103 FOURTH AVE., N.Y. 3, N.Y.

WEED PROBLEMS?

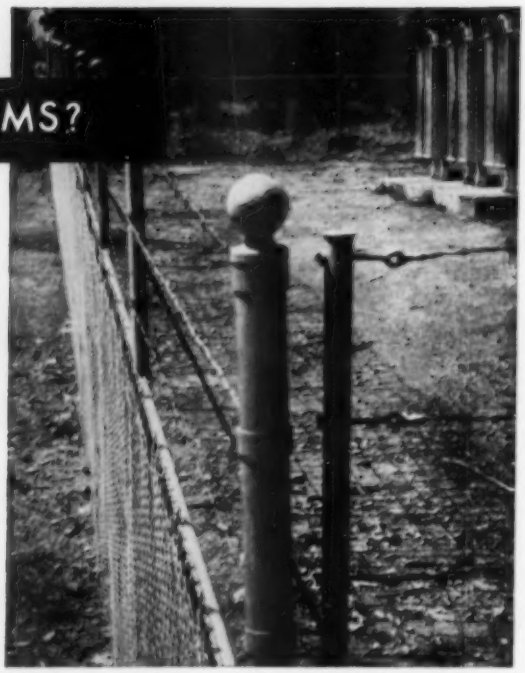
One application of

Du Pont Telvar®

WEED KILLERS

stops weeds for the season—or longer!

"Telvar" kills weeds through the roots . . . prevents regrowth. Low rates (20 to 80 lbs. per acre) make it cost little for the results you obtain . . . also mean less handling, fewer storage problems. To cut maintenance costs to new low levels, put "Telvar" in your weed-control program. Available in two formulations: "Telvar" W, and "Telvar" DW.



Note thorough job "Telvar" did around this fence. "Telvar" won't corrode fence or equipment, it's low in toxicity to humans and animals, non-flammable and non-volatile.

BRUSH ON RIGHT-OF-WAY?

Above—Right-of-way being treated with "Ammate." Below—Three years later, brush is still under control. "Ammate" allows low-growing cover to return to resist erosion.

One application of

Du Pont Ammate®

WEED AND BRUSH KILLER

kills more kinds of brush —safely—at lower cost!

"Ammate" kills more kinds of brush and keeps it down longer than most weed and brush killers! When the original spray job is done well, brush is kept under control for years with only an occasional spot spray. You can rely on "Ammate" to do the job safely, even where your right-of-way adjoins cropland, because "Ammate" is not volatile. There are no vapors to drift onto sensitive crops. It is no hazard to crews, stock or wildlife.

FREE ILLUSTRATED BOOKLETS describe how to control weeds and brush with Du Pont chemicals. For your copies, write to Du Pont, Grasselli Chemicals Dept., Rm. 4032, Wilmington, Del. In Canada, Du Pont Company of Canada Limited, Box 660, Montreal.

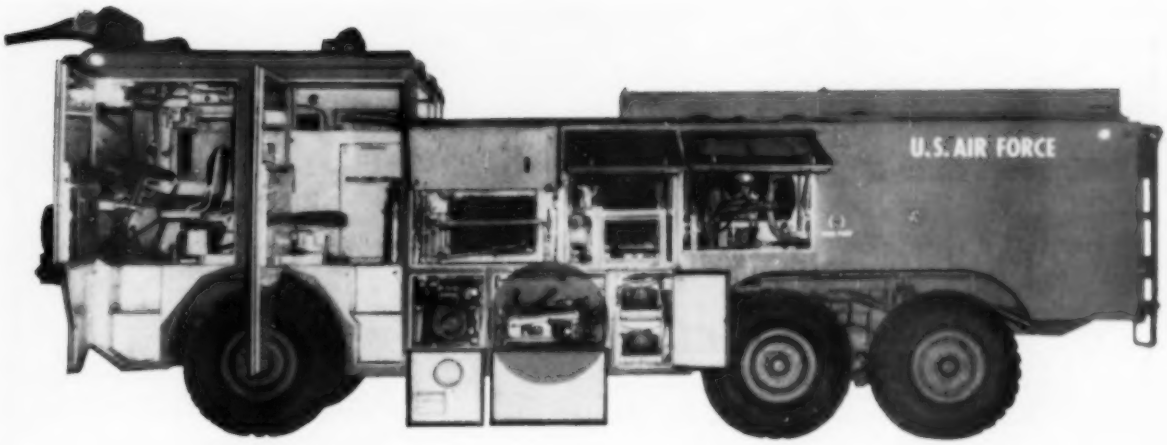
On all chemicals always follow directions for application. Where warning or caution statements on use of product are given, read them carefully.

Telvar® Weed Killers for industrial use

DU PONT REG. U. S. PAT. OFF.

Ammate® Weed and Brush Killer

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

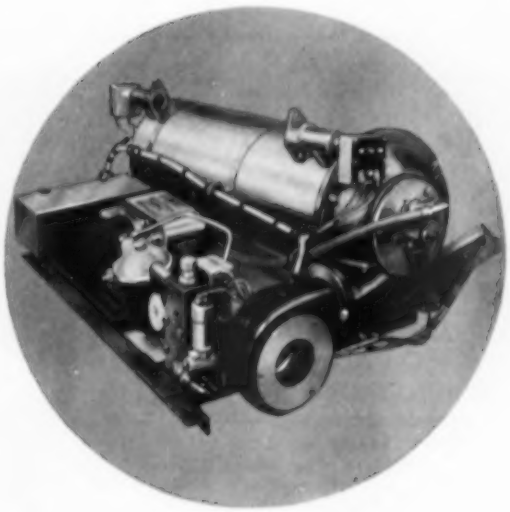


everything has to work...and it does!

Test personnel of the Air Proving Ground Command recently returned after more than 1000 hours of Operational Testing on the Type 0-11A USAF Crash Truck built by American-LaFrance-Foamite. A Janitrol 90,000 Btu/hr. Liquid Heater is standard equipment on this all-weather vehicle, and supplies all heating requirements.

No difficulties of any kind were experienced with the Janitrol heater in the 0-11A Crash Truck during the entire artic test period. Not once was any service necessary! Defrosting of the windshield was adequate with the assistance of the wipers in combatting the after-squirt from the turret dispenser nozzles. In a minus 41°F ambient temperature cab comfortization was maintained at plus 66°F, and in addition the Janitrol Heating Unit provided standby heat for the vehicle engine, pump engine, hose reel compartments, battery compartment and auxiliary power generator compartment. The main water storage tank was protected from freezing by a heat exchanger submerged in the tank.

No matter what kind of heat you may need—specify "Janitrol" and be sure of performance and dependability.



HEAT WHEREVER YOU WANT IT

Janitrol

AIRCRAFT-AUTOMOTIVE DIVISION, SURFACE COMBUSTION CORP., COLUMBUS 16, OHIO

District Engineering Offices: New York, 225 Broadway; Washington, D. C., 4650 East-West Highway; Philadelphia, Penna., 401 No. Broad St.; Kansas City, Mo., 2201 Grand Ave.; Fort Worth, 2509 Berry St.; Hollywood, Calif., 7046 Hollywood Blvd.; Columbus, Ohio, 400 Dublin Ave.

We Believe that Peaceful Co-existence is Best Maintained by being Too Tough to Tackle

MASON & HANGER — SILAS MASON CO., INC.

ENGINEERS and CONTRACTORS

Builders and Operators of Ordnance Facilities

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Fuller Gun Brushes On Active Duty

We are proud to be serving our Armed Forces with gun brushes. These brushes usually are available for an extra tour of duty because of their unique Fullergript construction. In this construction a tripled mass of brush material is loop-anchored inside a rigid metal backbone to provide a far denser brushing surface and extra long brush life.

INDUSTRIAL Fuller BRUSH CO. DIVISION

3585 MAIN STREET • HARTFORD 15, CONNECTICUT

Power driven brushes, Factory & Institutional cleaning tools, Waxes & Detergents

NOW SPRAY YOUR RUST PREVENTIVE!

RUST VETO *quick and handy!*

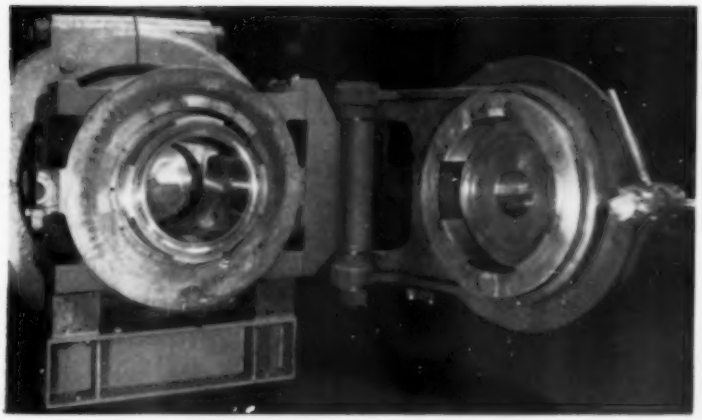
- Press button top for one-hand use
- Clear durable coating seals out moisture
- Dry film protects in storage and remains on metal in processing
- Great for tools, jigs, dies, idle machines

Price: $15.24 per case (1 doz. 12-oz. cans) f.o.b. Philadelphia, Penna. To order, clip ad to your letterhead or requisition and mail to E. F. Houghton & Co., 303 W. Lehigh Ave., Philadelphia 33, Pa.

RUST-VETO SPRAY
...a product of

E. F. HOUGHTON & CO.
PHILADELPHIA · CHICAGO · DETROIT · SAN FRANCISCO

Ready to give you on-the-job service...



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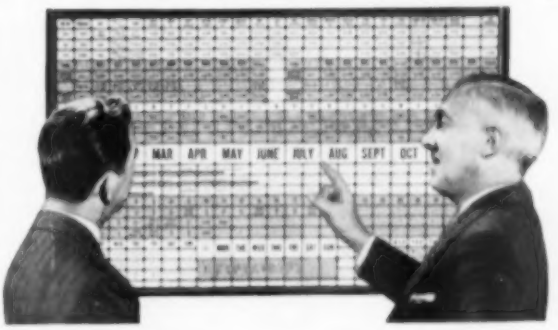

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ARMAMENT TECHNOLOGY

This section of ORDNANCE contains selected papers presented at meetings of Technical Divisions and Committees of the American Ordnance Association and contemporary articles on armament research, development, manufacture and field use

Cross-country Mobility

Land locomotion mechanics must receive the same emphasis as aëro- and hydrodynamics for global efficiency of our military vehicles

Col. Harold C. Parsons

Commanding Officer, Detroit Arsenal, Center Line, Mich.

MOBILITY, firepower, and protection are accepted as the three main factors which influence a battlefield operation. Firepower has apparently reached its ultimate strength through release of tremendous energy within the structure of matter itself and, as a result, protection through the use of a material shield has become most difficult.

The obvious and most urgent method of counterbalancing the unfavorable situation created by this introduction of atomic power must therefore lie in the radical improvement of vehicle mobility beyond all present conceptions and standards.

THAT this school of thought has spread across the world is evident in the current trend toward a reorganization of fighting units and adoption of such tactics as will offer the advantage of protection through quick cross-country dispersion and concentration.

Literature of this field indicates that, while most students of the problem stress the tactical and strategic factors involved in mobility, few will consider the question of mechanics and engineering concepts necessary to achieve the superior quality of locomotion desired by the strategist and tactician.

In short, it appears that most people are concerned mainly with the military aspects of atomic war without revising the locomotion concepts of automotive equipment which stand fundamentally unchanged since last tested on the "proving grounds" of the Spanish Civil War in 1936.

WE recognize three domains of locomotion: air, sea, and land. The first two have undergone an unprecedented revolution of mobility. The jet engine has enabled the airplane to reach the speed of sound and the level of the stratosphere while atomic propulsion of ships on and under the sea has opened possibilities which perhaps only a Jules Verne or an H. G. Wells could envision and properly describe.

In this race of progress, the auto-

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motive land-going machine has remained an orphan. It is true that today we have more engine power, higher octane fuels, and longer vehicle life, with greater economy of operation and more reliability and efficiency of the mechanisms in land vehicles—but do we have more mobility?

EVEN if the answer to this question were in the affirmative as some would like to say, whatever we have achieved in this field, particularly with reference to the cross-country vehicle, is practically nothing compared with the achievements in the mobility of a ship or of an airplane; yet mobility on the ground is no less important than mobility in the air or on the sea!

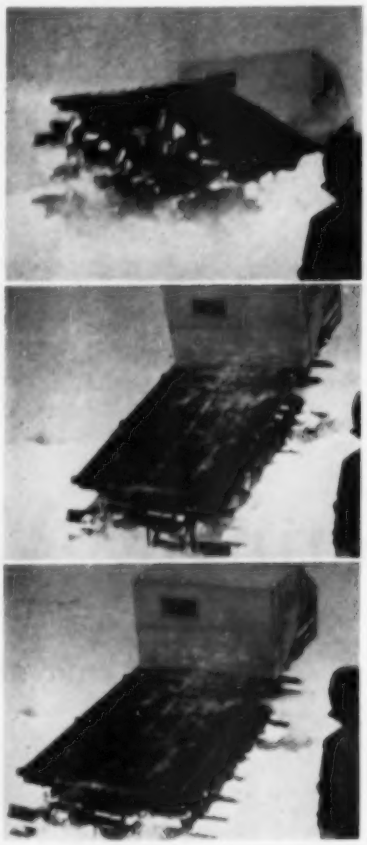
These facts did not entirely escape the attention of those responsible for an over-all evaluation of the problem. The Ordnance Corps has studied the situation since 1944 when insufficient cross-country mobility of automotive equipment was first dramatized by urgent reports from battlefield commanders.

Since then, research has been progressing steadily even in the period of reduced support during the pre-Korean conflict era. Much has been learned from research undertaken and aided recently by studies at the Operations Research Office of Johns Hopkins University operating under contract with the Department of the Army. Some causes of our difficulties have been examined and possible remedies indicated.

Upon examining previous attempts at solving urgent problems of land locomotion by means of scattered "projects" originated by a development engineer or ultimate user of a vehicle, we find that they expected a definite answer in one or two years to some of the practical difficulties encountered.

THIS leads to but one unavoidable conclusion: Such activity cannot bring about a systematic theoretical exploration of the whole field and cannot focus various efforts upon a single practical purpose.

This purpose may be envisioned as the establishment of a broad and more rational basis for an evaluation of mobility in automotive locomotion which would help to establish the most advantageous development policies. It



The experimental Groundhog negotiates a steep snow embankment during road tests.

then becomes evident that such a task must embrace two objectives—the study of a vehicle and a study of the environment in which it operates. Both studies are indispensable to produce engineering methods which would enable a development agency to design an optimum vehicle for the given environment.

However, the optimum design, necessarily expressed in physical and geometrical values of the vehicle and the corresponding terrain characteristics, cannot form a basis of development policies because these values have to be reassessed in terms of operational values in order to arrive at a compromise between the unavoidable conflicting conditions and requirements, with the maximum probability of success.

This is the task of such a rapidly growing new activity as the Operations Research Office. Evaluation of mechanical, geographical, and meteorological properties of terrain from the locomotion point of view has been traditionally the task of the Corps of Engineers while the mission of the Ordnance Corps has been to meet the requirements of engineering assessment study and design of an ordnance vehicle.

With these three main agencies involved, the problem of studying land locomotion obviously cannot be solved by piecemeal methods; it requires a well-integrated, concentrated, and thoroughly coördinated effort by all parties concerned.

Since vehicles of improved mobility are the ultimate goal and one of the important missions of the Ordnance Corps, the Detroit Arsenal recently was requested to establish a new operating division devoted solely to the task of systematically studying ways and means to improve the performance of motor vehicles, particularly in off-road operation.

BEFORE the organization and program of the Land Locomotion Research Laboratory were conceived, there was a need for a more rigorous formulation of the problems and possible methods of attack, but the experience gained by the Ordnance Corps in work performed during the past ten years did not fail to provide clues in that direction.

Engineeringwise, the problem is to determine whether a given vehicle can or cannot traverse a certain structure built of a granular soil mass without breaking through. Moreover, it is essential to know how much such a structure may yield under vehicle load in order to prevent bogging down and ensure adequacy of traction of the vehicle.

It appears safe to assume that the problem is similar to that of determining the strength and deflection of a bridge under the action of forces applied to the bridge structure by the crossing of a vehicle.

BUT before the problem of cross-country locomotion can be solved, a new type of applied mechanics must be developed which would relate the strength and deformation of the soil mass supporting a vehicle to the loads and dimensions of that vehicle.

In principle, this problem could be solved by applying the bridge-crossing methods of solution; it requires but a systematic application of existing laws

of physics to the relationship between a vehicle and the environment of its locomotion.

A similar application of physics to formulating the relationship between an airplane and air, which is its environment, has led to the development of aërodynamics. The same procedure has established hydrodynamics which defines quantitatively the relation between the medium of water and a ship or torpedo.

By analogy, it may then be concluded that the establishment of what may be termed "terradynamics" is a necessary prerequisite of eventual progress in land locomotion. Such a task should not be complex since both the basic laws and the methods necessary for its completion are known.

However, the simplicity of the principle does not necessarily predetermine the simplicity of the detailed work involved. The following comparison may explain the nature of the problems which the mechanics of automotive land locomotion has so far revealed.

LET us examine more closely the previously mentioned example of bridge crossing. If we assume that we wish to know whether the given bridge will support a given vehicle, the engineer must know three things: (1) The type and distribution of loads along the contact area between the vehicle and the bridge as well as the form and dimensions of that area; (2) The detailed dimensions and form of the bridge structure as well as of the elements of which the bridge is made; and (3) The mechanical strength and modulus of elasticity of the metal used in the construction of the bridge.

Once these three groups of data are known, proper equations may be found in an engineering handbook and the problem solved.

By the previous analogy, a similar group of data is required to solve the problem of crossing a "bridge" made of soil. However, these data become more complex when we try to apply them to granular masses of sand, clay, or snow instead of to the metal of the bridge. The type and distribution of loads along contact areas between a vehicle and the ground are not yet known sufficiently well despite all the work performed to date in this field by automotive engineers.

For instance, the contact areas and pressures beneath pneumatic tires have been studied exhaustively, but on hard pavement only; very little has been done with reference to soft ground.

It is true that the detailed dimensions and forms of the "bridge" composed of soil supporting the vehicle in motion are in principle known from studies made in soil mechanics by civil engineers, but the complexity of "footings" supporting the vehicle is of a somewhat different nature from that of foundations supporting buildings and dams. In addition, although methods of determining the strength of soil in critical conditions have been determined in civil engineering, it is not so much the strength itself as its relation to soil deformation which seems to open up new problems with reference to vehicle motion.

To illustrate this point, it may be mentioned that "elastic" soils are not a problem from the trafficability point of view since they belong in the category of hard pavements; the problems are posed by "plastic," yielding soils. Thus, instead of the single modulus of elasticity which is sufficient to determine the deflection of the metal bridge, we have at least two moduli of deformation of the ground—one in the vertical direction which gives the concept of sinkage, and the other in the horizontal direction which determines the amount of slippage of the vehicle.

Such data, when properly evaluated, will be fed into formulae which must be established, and only then may we hope to solve our problems.

IT must again be stressed that the problem of establishing this new applied mechanics, though simple in principle, is extremely complex in actual solution. It would be a misrepresentation of the problem to state that such a broad task may be solved in any specific time by some group given merely the financial means and the mission.

Only a coördinated professional effort with the full coöperation of interested Government agencies, universities, and industry can lead to a healthy development of this new and vital field.

Recognizing this need, the Land Locomotion Research Laboratory of the Detroit Arsenal in an effort to help promote interest in the field of mobility has formulated scientifically the various phases of research work required to reach practical solution of improved locomotion.

Only in this manner can we hope that the mobility of an automotive land vehicle will be increased in a way comparable to the general technological progress of the age.

The new spaced-link track is tested on an experimental model at Detroit Arsenal, Mich.

High-speed Fighter Aircraft

The Air Force Convair F-102A all-weather supersonic fighter, above, shows the recently revealed "wasp-waist" fuselage which has resulted in a speed increase of up to 25 per cent (Air Force photo). The North American F-100C Super Sabre, below, with in-flight refueling system and extra fuel drop tanks can carry the atomic bomb at supersonic speeds.

Making 90-mm. Cases

An informal discussion of the practical problems encountered in manufacturing cartridge cases from round-cornered square billets and the methods used to overcome various difficulties

L. G. Soper

EXPERIENCE in shell manufacture, by both the hot and cold method, has indicated that there are many advantages in the use of the round-cornered square billet. Our company has run tests checking the flow of the material, the grain, etc., and believes there are some definite advantages including, of course, some cost advantages.

There is quite a problem in the round bar with seams being rolled into the surface—a great deal more than in the round-cornered square. In the 90-mm. we are using a 4¼-inch round-cornered square billet.

Our piercing operation is performed after a modified upsetting operation, in which we upset the billet until it fills the pot completely to a round. Our work to date has been restricted entirely to the making of cups. Since we started this about 2½ months ago, we have made cups by about twenty different methods, and we are now trying to pick those methods which are most feasible.

WE are also at the present time running some material with the bar laid on its side.

The problem of concentricity is a big one to most manufacturers in the formation of hot cups. When we embarked upon the tooling of shell lines, it appeared to be one of the biggest problems which confronted us. However, in the development of dies since then, maintenance of .006 to .008-inch total indicator readings has proved to be a very small problem.

Mr. Soper is vice-president in charge of engineering, National Presto Industries, Inc., Eau Claire, Wis. This paper was given at a meeting of the Cartridge Case Committee of the Bomb and Artillery Ammunition Division, American Ordnance Association, held at the Naval Ordnance Laboratory, White Oak, Md.

The other problem that confronted us then, and still confronts us with the cartridge case, is the surface condition of the billet. We finally found a very successful solution which is a simple wheelabration performed after the sawing operation.

We also have done a considerable amount of work breaking bar into billets rather than sawing. In breaking billets for the 105-mm. shell we got a very ragged edge on the top, and when we tried to forge it back we got incomplete welding of this edge. As a result, the interior surface would have a notched section that we believe would definitely lead to breakage, so we immediately abandoned it.

At the present time in the work on cartridge cases the pieces are cut by a band-saw which can sever a 4-inch bar in thirty-seven seconds.

After we cut the billet to length we go through the wheelabrating operation and wheelabrate the surface which also tends to knock off the small burr which we get on the bottom side where the band saw leaves.

After removing the parts from the wheelabrator, we are using two methods of heating—one is an induction system in which we can push the bars through; the other is an experimental atmosphere control gas furnace. We then put the bars into the forging press.

FORTUNATELY, we have some large 3-stage transfer presses, and we intend to take three operations in the forging process, which is the maximum we can get in the one heat of the steel. By the use of induction heating the total heating and forging cycle is very short—less than 3½ minutes. This is an important factor in minimizing the formation of scale which is very detrimental to dies and also to the work being processed.

After slow cooling, the forging is wheelabrated on both the interior and exterior surfaces until they are chemically clean. This gives us another distinct advantage, we think, in that it will eliminate the need for an acid pickling operation prior to phosphatizing. After wheelabrating, a phosphate coating and lubrication is applied to the surface of the cups. So far, the coating and the results obtained therefrom have been excellent.

The 105-mm. Cartridge Case

Use of unspheroidized steel plate in an emergency situation

L. N. Peterson

DURING the Korean hostilities there was a serious shortage of spheroidized steel plate for the manufacture of cartridge cases, and consequently many manufacturers sought some method of producing cases from unspheroidized material. Regal Ware contacted the Ordnance Corps to determine whether they were interested in our undertaking development work of this type. When Ordnance agreed with our suggestion, we embarked upon a program with the procurement of five small lots of steel from Inland Steel Co. We identified each of the five lots as shown on the left margin of Table 1 (E28A, E29, E30A, E31A, and E32A). Also shown are the chemical analysis for each lot, Rockwell hardness values, quantity of disks processed, and the number of pieces which were eventually scrapped.

An examination of the chemical analyses for these heats shows that the carbon contents range from 0.25 per cent to 0.33 per cent which is fairly representative of the permissible variation in carbon analysis for cartridge-case plate. The spread in the manganese content is not significant, ranging only from 0.70 to 0.75 per cent.

THE as-received Rockwell hardness, as might be expected, is highest for the lot which has the greatest content of carbon, B 80, and the lowest for the lot with the least carbon, B 75. Before attempting to cup the disks, we gave them a pass through the process annealing furnace. In Table 1 the second column of figures under Rockwell hardness shows the values which were obtained after this operation. Note that the hardness for lot E29 dropped from B 80 to B 74 and that for lot E30A, from B 75 to B 74.7.

Mr. Peterson is executive vice-president of Regal Ware, Inc., Kewaskum, Wis. This paper was given at a meeting of the Cartridge Case Committee of the Bomb and Artillery Ammunition Division, American Ordnance Association, held at the Naval Ordnance Laboratory, White Oak, Md.

The last two columns of Table 1 show the quantity of disks which were started through the processing operation and the quantity of disks which were scrapped. Lot E29 which has the highest carbon content also shows the highest percentage of scrap loss, which is what we would expect.

The totals show that we ran nearly 71,000 disks of which slightly more than 7,700 were scrapped, or approximately 11 per cent.

Now I'd like to point out just where in our processing this scrap was generated. Twenty-four per cent occurred during the cupping operation, whereas in normal operations using spheroidized plate we would expect to encounter not more than two or three broken cups during eighteen hours of operation.

With the first drawing operation, which is the point at which we have our highest percentage of scrap with spheroidized steel, in processing unspheroidized plate we had 19 per cent of the total scrap. Percentagewise this is about the same as for our regular operation.

The next point at which we experience any significant scrap loss is the third drawing operation. In processing unspheroidized steel plate we had 12 per cent of our total scrap occur at this point, which is higher than we normally experience. In the heading operation, we lost about 0.8 per cent because of failure to fill the flange.

On the tapering operation our scrap ran 12 per cent of the total, which is about normal, and in machining we lost approximately 0.5 per cent of the total. The balance is attributable to rework and repair operations.

Table 1. Statistical record of nonspheroidized steel used in case manufacturing.

Lot No.	Chemical Analysis					Nonspheroidized Steel		
	Car.	Mang.	Phos.	Sul.	Si.	Rockwell B of disk	Pieces started	Pieces scrapped
E28A	.28	.70	.010	.026	.08		692	69
E29	.33	.73	.008	.027	.05	80–74	603	144
E30A	.25	.74	.018	.024	.06	75.0–74.7	757	36
E31A	.27	.74	.011	.025	.07	78.2–76	681	62
E32A	.29	.75	.010	.025	.07	77.3–75.2	723	23
25233	.29	.75	.010	.025	.07	82–82	20,556	3,692
25234	.29	.73	.011	.026	.07	78–78	25,280	1,372
25235	.30	.71	.010	.026	.07	79–79	21,546	2,313
Totals							70,838	7,711

The Multipiece Case

This type has several advantages over the one-piece drawn cartridge case since it does not require special press or forging equipment and can be made both quickly and economically from commercial steel

R. J. Wilcox

I WOULD like to discuss here some of the background in developing manufacturing procedures for producing 106-mm. multipiece cartridge cases and to list some of the advantages of multipiece construction over the one-piece drawn case.

The multipiece cartridge case consists of two components—the tube and the head—which are joined together by copper brazing. The basic manufacturing improvements over the one-piece drawn brass or steel cartridge case may be summarized as follows:

1. The one-piece drawn case requires specialized punch press equipment and many specially constructed process annealing furnaces. By comparison, the multipiece design can be produced on a minimum of specialized equipment and requires no process annealing.

IN case of an emergency, many manufacturers have presses and experienced personnel that could be diverted to forming cartridge case tubes in a relatively short time. These advantages broaden the field of manufacturing concerns which may be capable of more readily acquiring suitable production equipment.

2. Another element of considerable interest is the relative availability of materials. The commercial cold-rolled steel, as required for multipiece cases, assures the most rapid delivery. The simplicity of head forging also places it well within the range of existing forging facilities. By comparison, spheroidized steel blanks for the drawn case are not as readily available and could present a supply problem.

3. Economies and production rates are other factors involved. As previously indicated, there are none of the costly annealing operations in the production of multipiece cases. Also the special handling and controls necessary in steel mills result in increased material cost when using spheroidized blanks. As the multipiece case utilizes rectangular rather than circular blanks, the scrap loss is reduced accordingly. The standard short-stroke presses used in processing the multipiece tubes are many times faster in unit production per hour than the special long-stroke hydraulic presses commonly employed for drawn cases.

The Motor Wheel Corporation, having manufactured cartridge cases, rockets, shells, and other Ordnance requirements, became interested in the 106-mm. multipiece recoilless cartridge case in 1953. Following a preliminary planning period, supply and facility contracts were signed. The program was initiated with a careful study of various processing methods, and that which appeared most practical was selected and tooled accordingly.

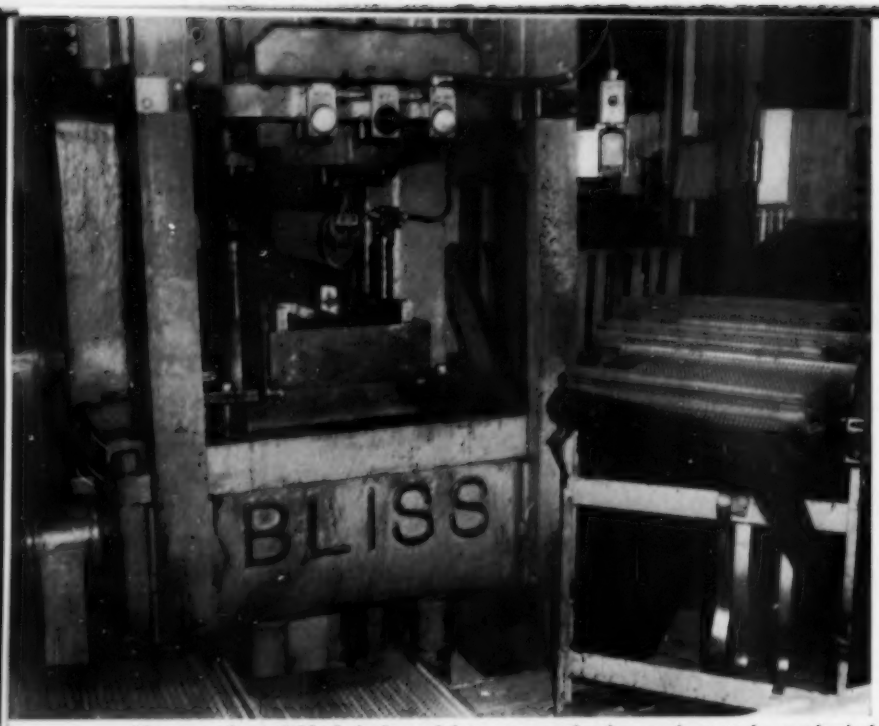
Mr. Wilcox is executive engineer, Motor Wheel Corporation, Lansing, Mich. This paper was given at a meeting of the Cartridge Case Committee of the Bomb and Artillery Ammunition Division, American Ordnance Association, at the Naval Ordnance Laboratory, White Oak, Md.

THE manufacturing process planned and developed by Motor Wheel for producing the 106-mm. multipiece cartridge case consists of the following basic operations:

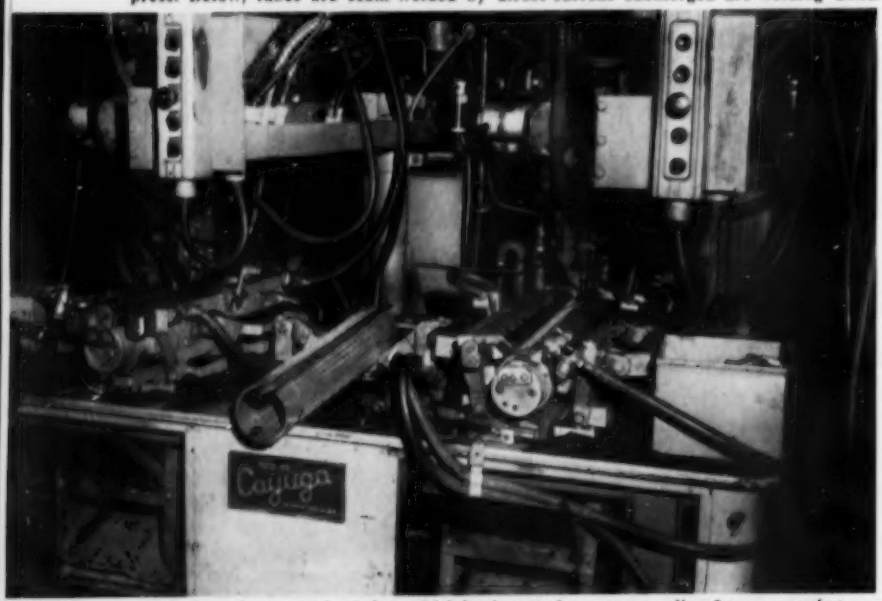
WD-1030 cold-rolled steel is purchased in sheet form from which blanks are sheared to developed size. Each blank is then perforated in two 400-ton mechanical punch presses with two strokes per blank in each press. The 1,160 holes so formed are spaced in such a manner that multiple operations are necessary to accommodate die construction and at the same time maintain high accuracy and low cost.

The blank is located in the first piercing die where 290 holes are formed. Next, the part is stripped from the punches and is automatically transferred to position No. 2 in the die. The press continues to cycle without stopping and pierces a second group of 290 holes. The second perforating press performs the balance of the two piercing procedures and operates in the same manner as the first press.

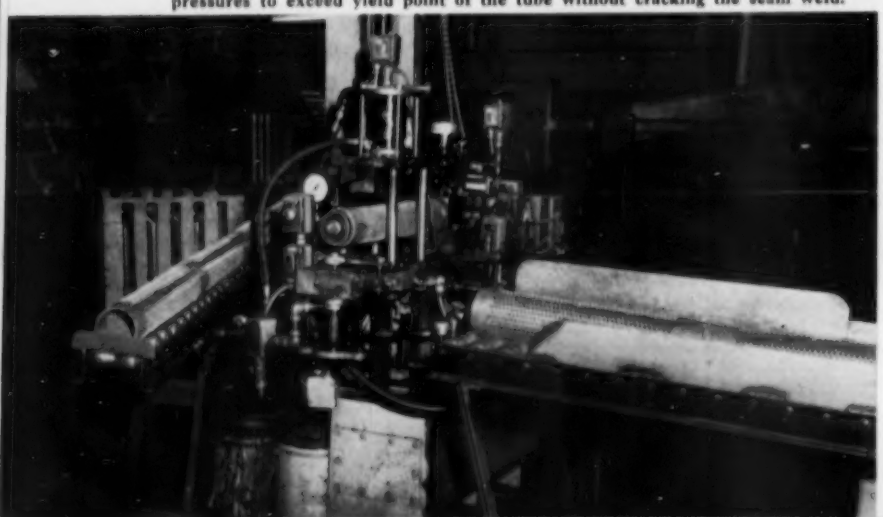
After leaving the two presses the perforated blank is trimmed to proper con-



Above, perforated blank is formed into a tapered tube on short-stroke mechanical press. Below, tubes are seam-welded by direct-current submerged arc-welding units.



Below, the strength of the weld joint is tested on an expanding fixture exerting pressures to exceed yield point of the tube without cracking the seam weld.



tour and then is formed into a tapered tube by three die operations. All three of these are performed on a short-stroke mechanical punch press.

THE related development program involved experimental tests to evaluate various methods for producing tapered tubes. One of these efforts included the mechanical expansion of a commercially straight welded tube of an original diameter equal to the minimum shell diameter. Another test was conducted by starting with a tube conforming to the largest case diameter and reducing it to the required taper. Still another experiment involved the preparation of a tube to the mean diameter and simultaneously expanding one end and reducing the other. None of these was satisfactory because of excessive disturbance in the side-wall area.

From this background the process in present use was selected employing a developed blank, the shape of which when formed and welded provides a tapered tube. In addition, the experimental work indicated that a greater degree of uniformity in forming operations was accomplished with the grain of the metal directed circumferentially. A more efficient usage of the steel also resulted.

Returning to the description of the production processes, the finish formed tubes are cleaned and then seam-welded by direct-current submerged arc-welding units to one hundred per cent weld penetration. Satisfactory welds have been attained through extensive development of this equipment. Some of the necessary fundamentals are: a water-cooled backup bar, precision electronic controls, a uniform wire feed, a positive mechanical part-holding fixture, and a device capable of maintaining constant welding speed.

THESE factors, plus the application of general welding skills, provide a very satisfactory and efficient operation. To further ensure a sound weld, waste tabs are placed on each end of the tube to eliminate burnout. The waste tabs are then removed from the tube ends and the weld scarfed in a horizontal flash trimming machine.

The strength of the weld joint is tested as a one hundred per cent operation by means of a hydraulic expanding fixture designed to exert pressures

sufficient to exceed the yield point of the tube without cracking the seam weld. A problem arose concerning the development of an operating cycle fast enough to maintain line production. This was solved by incorporating in the machine an automatic straightening and ejection mechanism.

THE tube at this point, because of the weld test, is out of round and must be resized, which is done in a horizontal rounding die. A cleaning operation follows in preparation of the tube for assembly to a semifinished head.

The head is rough-machined from a forging on a 6-spindle vertical lathe. The machining consists of finish turning the pilot diameter, drilling the primer hole, and rough facing the base end.

The tube, head, and a copper brazing ring are then assembled in a hydraulic machine and are placed on trays which are automatically transferred into a hydrogen-atmosphere controlled furnace where the head is copper-brazed to the tube. A very important development in connection with the copper-brazing operation is the control of the press fit for maintaining the quality of the brazed joint.

This is accomplished by sizing the inside diameter of the tube at the head end in an expanding die and maintaining a very close tolerance on the mating surface of the head. The areas to be joined of both the head and the tube are formed on a common angle which further ensures the required press fit as well as assisting in the assembly of the two parts.

A TAPER-SIZING operation for forming the required tube contour is next in the sequence and is performed in a conventional mechanical punch press. A dial feed is utilized here for ease of loading and unloading parts.

One difficulty involved in developing a satisfactory forming die was to control the stock movement in order to ensure a dimensionally uniform cartridge case. We learned that it is very important at this stage to make the case as nearly round and true as possible. This is necessary to minimize the distortion in the heat-treating operation which follows.

The specified hardness is Rockwell C 30 minimum except at the mouth end, which is B 90. The heat-treating operation is performed in an automatic salt pot installation consisting of six stages: hardening furnace, brine quench, dry-off, mouth anneal, draw, and rinse.

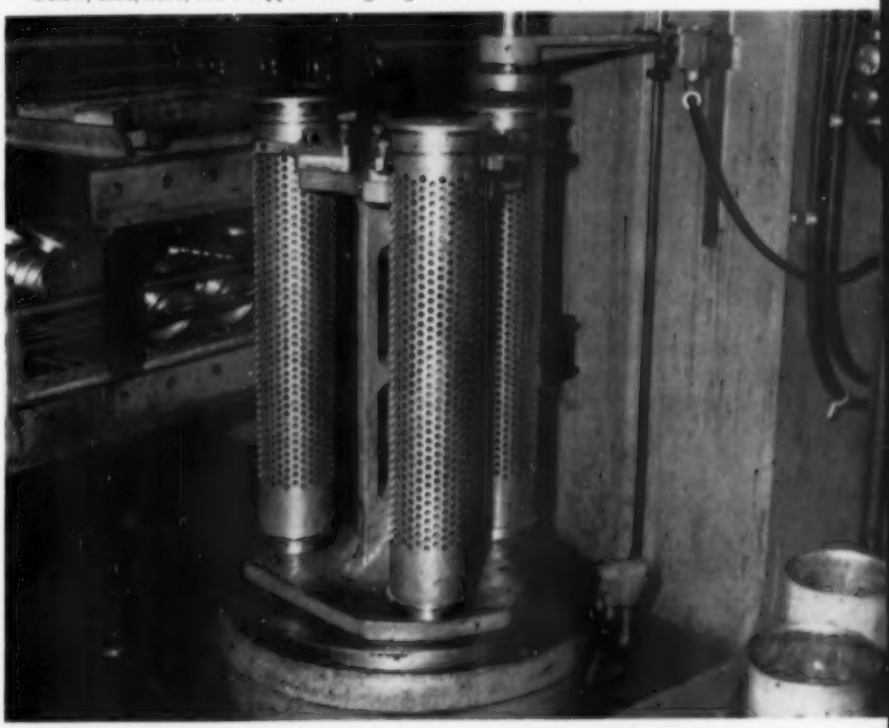
The final sizing die, a vertical-chamber type, corrects the distortion resulting from heat-treating and prepares the case for the finish-machining operation.

Reaming the primer hole and final inspection prepares the case for a preparatory phosphoric acid etch, followed by phenol varnish dip and bake. The finishing operation includes a 5-stage washer, a dry-off section, a varnish dip tank, an electrostatic detearing grid, and baking oven. The unit is entirely automatic.

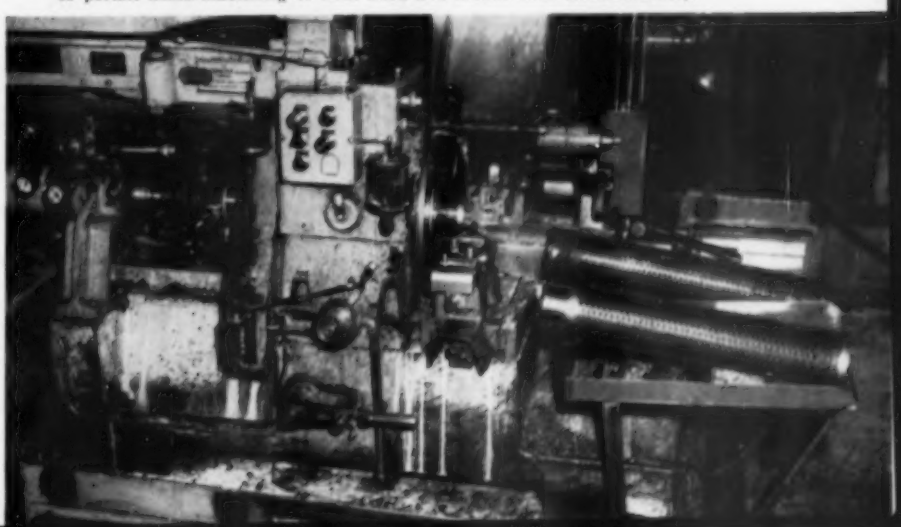
We have learned through our development program that several factors must be maintained to ensure a satisfactory finish. Some of them are:

(1) Very close control of varnish viscosity and temperature, (2) Entry angle and rate of lowering the cartridge case into the varnish tank, (3) The speed and angle at which it is removed from the varnish, (4) Location of the electrostatic detearing grid, and (5) The time and temperature in the prebake and bake operation.

Below, tube, head, and a copper brazing ring are assembled in hydraulic machine.



Below, finish-machine operation is done on a single-spindle lathe designed to permit finish-machining of both head and mouth ends simultaneously.



The Spiral-wrapped Case

A production line can be placed in operation in less time, in a smaller area, and will turn out artillery cases of this type at less cost than with conventional one-piece design

H. M. Callahan

THE original cartridge case of spiraled-wrapped design was manufactured at Frankford Arsenal. It was designed for use with small arms and was patented on December 15, 1863. The case was manufactured from thin brass sheet with the brass section crimped and reënforced.

This was about the time when the initial experiments with metal cartridge cases and breech-loading rifles were being carried out, but there is no indication that this cartridge case was developed beyond the experimental stage. The next evidence of such a case is a 37-mm. Hotchkiss of French design, and it is also believed than an English arsenal made some investigations on spiral-wrapped cartridge cases at about the same time.

The recent development of spiral-wrapped artillery cartridge cases conducted in this country is based upon a report prepared by the armaments design department, Ministry of Supply, Fort Halstad, Kent, England, in February 1946. This report is a résumé of German research on cartridge cases conducted during World War II when shortages of material and manufacturing capacity were most critical.

THE report deals with solid-drawn, fabricated, partly consumable and wholly consumable cartridge cases. The Kent report indicates that spiral-wrapped cases were used in the field by the Germans during this period. For separate-loaded ammunition for weapons, such as howitzers, cases were produced up to twenty-one centimeters in size, and their performance was considered to be very successful.

Mr. Callahan is industrial engineer with Rheem Manufacturing Company, New York, N. Y. This paper was given at a meeting of the Cartridge Case Committee of the Bomb and Artillery Ammunition Division, American Ordnance Association, held at the Naval Ordnance Laboratory, White Oak, Md.

Production of solid-drawn cartridge cases requires factories equipped with large special presses, heat furnaces, and special lathes. Designing, equipping, and erecting such a plant takes a considerable length of time. For spiral-wrapped cartridge-case production special machines are required only for machining the sheet for the body and for forming the correct external shape, and these machines can be readily acquired.

The balance of the manufacturing operations can be performed on normal commercial lathes, and therefore a new facility can be established for production in a comparatively short time. This is a consideration of paramount importance during periods of national emergency.

Sections of German multipiece steel cartridge cases for 100-mm., 105-mm., and 152-mm. guns were forwarded to Frankford Arsenal for metallurgical examination. This examination was started in November 1945, following which Frankford Arsenal performed numerous engineering studies which culminated on December 15, 1950, with ballistic tests conducted on sample 105-mm., M14B1E, spiral-wrapped cartridge cases which were fired at Aberdeen Proving Ground. In general, these samples proved satisfactory.

THE success of the arsenal's early ballistic testing program on the spiral-wrapped cartridge case was such that expansion of the development program was authorized. A meeting of the interested contractors was held on March 13, 1951, at Frankford Arsenal, at which time drawings to control the outside contour of the cartridge case and basis of procurement information were distributed. Arsenal representatives, who had manufactured the first 105-mm. spiral-wrapped cases were present to describe the various methods of manufacture which had been used by the arsenal.

The critical shortage of spheroidized plate which threatened to curtail the manufacture of drawn cartridge cases during Korea resulted in an acceleration of the program to develop and manufacture the 105-mm., M14E1, cartridge case.

Armament Technology

A meeting was held at the Office of the Chief of Ordnance on November 13, 1951, with the key representatives of three firms who had spiral-wrapped cartridge-case contracts at that time. One of these firms was Rheem. We performed all manufacturing operations on the body and on the collar at Sparrows Point, but we purchased the seal, the completely finished base and the uncoated nut.

Wrapped sheet metal cartridge case made at Frankford Arsenal in 1872.

THE sheet from which the body is rolled is trapezoidal in shape. Our first operation after shearing the sheet was to blank the trapezoid.

After the milling operation we chamfered the edges of the blank because, as a result of our early experimental work, we were convinced that we could not tolerate any sharp edge at the spiral. We then deburred the sheet, and it was ready for the cleaning operation.

Next we roller-coated the blank in two passes to coat both surfaces with varnish and baked the varnish to produce a hard protective coating. The blank was then ready for the rolling operation. The next step in the manufacture of the body is the flanging operation. This consists of forming the portion of the body in which there are three layers of metal—a tricky operation solved by automatic machines.

After the spinning operation, the body is sized. This is accomplished by placing a rubber block inside the body and confining the outside diameter with a die of appropriate size. A pressure of 150 tons was exerted on the rubber during this operation. Next, the opening in the spun section is pierced. During the early stage of manufacture this opening was machined on a lathe, but since we developed a piercing die the job has been a very simple one.

The finished body was then washed and dried, and any surfaces which had been marred or damaged due to handling in the above operations were touched up with varnish.

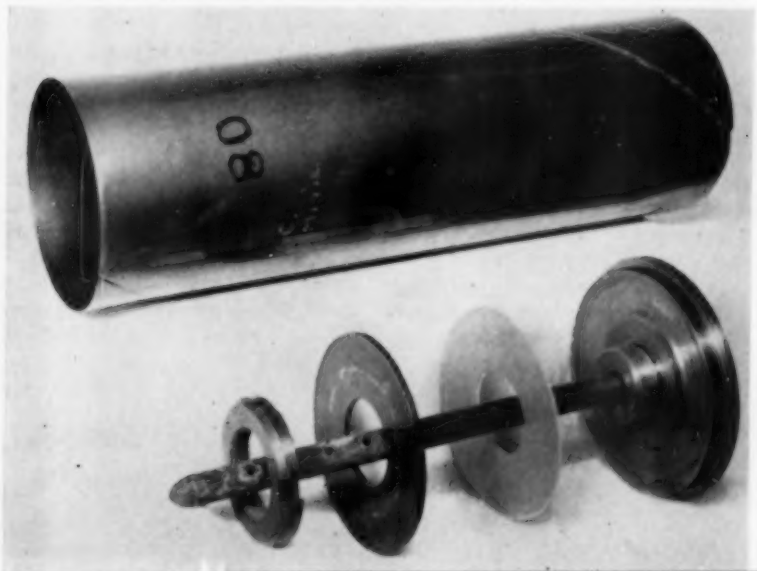
With respect to the collar, we produced this part on 2-stage progressive dies which blanked out the outside diameter and hole in the center. The collars were washed in the same equipment used for cleaning the bodies, following which they were dipped in lacquer and baked.

The various parts: body, collar, nut, seal, and base are now ready for assembly. The first step of which is to make a preassembly on a stake-type fixture.

SOME of the asset features of this case that we are enthusiastic about are listed as follows:

1. A production line can be placed in operation in about one-third the time required for deep-drawn cases.
2. The manufacturing area required is about one-third that required for a drawn case.
3. The cost of a production line geared to produce 100,000 spiral-wrapped cases per month is approximately one-quarter the cost for production lines that produce a like quantity of the one-piece design.
4. Critical metallurgical control of heat treatment or cold-working is not required with this design. Hence, there are no requirements for highly specialized metallurgists, tool and die makers, lubrication experts, and process-control personnel.
5. Commercial quality steel is satisfactory, and small metal imperfections have been regarded as a minor consideration with this design.
6. The rejection rate from any operation is low, and in the event of damage all parts are not lost.
7. Several million 105-mm., M14E1, cases have been produced and ballistically accepted, meeting the same criteria as other cases of this size; namely, 36,400 p.s.i. test pressure.
8. The inherent advantage of this spiral-wrapped case when subjected to internal ballistic pressure is to elongate, using the spiral seam as an expansion joint, rather than to enlarge elastically and plastically within certain limits.

Exploded view of a modern 105-mm. cartridge case made by the spiral-wrap method.



During our production contract at Sparrows Point, we produced 128 lots of 105-mm., M14E1, cases. Of that total, two lots were rejected. Rework consisted mostly of merely resetting the assembly torque of the nut.

At present, a new design for the 105-mm. case is being developed on which very limited firing tests have been performed. Performance probably will be improved and the cost reduced.

A New Twist

Because it is usually employed with low-velocity weapons, the spiral-wrapped case permits the use of materials and equipment far less critical than those required on conventional cartridge case lines

H. F. Goetz

THE Buffalo plant of Fedders-Quigan is producing a spiral-wrapped cartridge case which is simple in design and which has proved its worth in a very short period of time. The equipment that we use is a far cry from that used to produce the conventional 105-mm. howitzer case.

The idea of the spiral-wrapped cartridge case isn't new. We know that some were made back in the 1880's, but the principle was somehow overlooked for a long time until some one realized that there might possibly be an easier way to make cartridge cases than by the conventional drawn method.

Fedders was invited into the picture by Frankford Arsenal in June 1951 when we were asked to help develop a double-wrapped 76-mm. cartridge case. We actually made a few cases and had some of the problems solved, on paper, at least, by November 1951. At that time the services were faced with a real need for greater production of the 105-mm. cartridge case.

SOME alternative to conventional production methods had to be found, and spiral wrapping seemed to be an excellent prospect. By that time we knew something about double-wrapping a case, but specifications for the 105-mm. called for a triple-wrap, and that innocent little difference caused us and two other contractors many headaches.

When we tried to form a tube from a trapezoidal sheet of steel, the tube resisted our efforts to spin one end of the bore satisfactorily. One contractor had developed a method of spinning the tube from a single trapezoid, or a regular trapezoid, by applying heat to that region of the tube to be formed during the spinning operation. The other contractor had done some work with an irregular hexagon which produced two bodies after the spinning operation but without the use of heat.

All our efforts had been directed to the latter method, and by early 1952 we had found a comparatively simple solution to this problem and still use it today. Spinning a spiral tube that produced two bodies simplified a lot of handling on the production line prior to the completion of the spinning operation.

The one contractor who was using the single trapezoid, or the regular trapezoid, eventually developed a successful method of spinning a single body without the use of heat. However, we feel that the irregular hexagon offers certain advantages from the time it is blanked through the spinning operation. Compared with the conventional deep-drawing operations, ours look like little more than ten snips on a couple of lathes.

Our milling machine is one of only two pieces of special equipment in our line. The milling cutters are arranged so as simultaneously to mill two trapezoidal reliefs which are required to keep the blank within the body thickness prescribed at the mouth where the two ends overlap. On completion of this first milling operation the operator simply turns the blank end for end and mills more reliefs. Then the blank is completely machined.

OUR bonderizing unit is a 5-stage conventional unit. Each rack carries metal parts to make two cartridge cases—a blank which is eventually cut in half, a nut, a collar, and a base for each of the two bodies.

Our roller-coating operation is accomplished by a conventional roller coater which applies a fine coat of phenolic varnish to one side. The blank then passes through a drying oven with a wicket-type conveyer to a second roller coater where phenolic varnish is applied to the uncoated side, and the blank proceeds through a second oven at which time the varnish on both sides is fully cured.

Since each blank represents two

Mr. Goetz is manager, ordnance sales, Fedders-Quigan Corporation, Buffalo, N. Y. This paper was given at a meeting of the Cartridge Case Committee of the Bomb and Artillery Ammunition Division, American Ordnance Association, held at the Naval Ordnance Laboratory, White Oak, Md.

bodies, operations here are half of what would be required if we used a regular trapezoidal blank. After the prime coat of varnish is cured, each blank is processed through a conventional sheet-rolling operation, producing a loose "stovepipe" which eventually will become two bodies.

The pipe is then separated into two pieces and now has some resemblance to a cartridge case. The machine is a conventional engine lathe, with special tooling to adapt it to production requirements. This particular operation was one of the two really major obstacles that we had to overcome in developing a production method for these cartridge cases. The spinning roll forms the base of two bodies. Then a cutter on a yoke is slipped over in front of the roll, the pipe is separated at the center, and we have two partly formed bodies.

AFTER these two partly formed bodies leave the lathe, a simple press operation flattens the base of the body in the region that has been spun and preforms it prior to the final sizing operation.

Our sizing press is a conventional 200-ton arbor press, modified for quantity production. The press has two dies mounted on a dial permitting the operator to load one die while a part is being sized in the other.

"After 3½ years of development, we can turn out a serviceable item which is competitive in cost to the drawn case. . . . Total outlay required to set up a 105-mm. spiral-wrapped cartridge-case line is estimated as one-quarter to one-third that required for the conventional case line."

During the early phase of production, sizing was one of our biggest headaches. Radial cracks developed in the base of the body and, of course, whenever this happened the body was rejected. At that time specifications called for half hard steel for the bodies (Rockwell B 75-85). This temper requirement was altered to permit a 15-point spread, Rockwell B 70-85. Additional relief was obtained when the design agency made the temper of the body steel advisory only, which enabled us to eliminate the problems in our sizing operations.

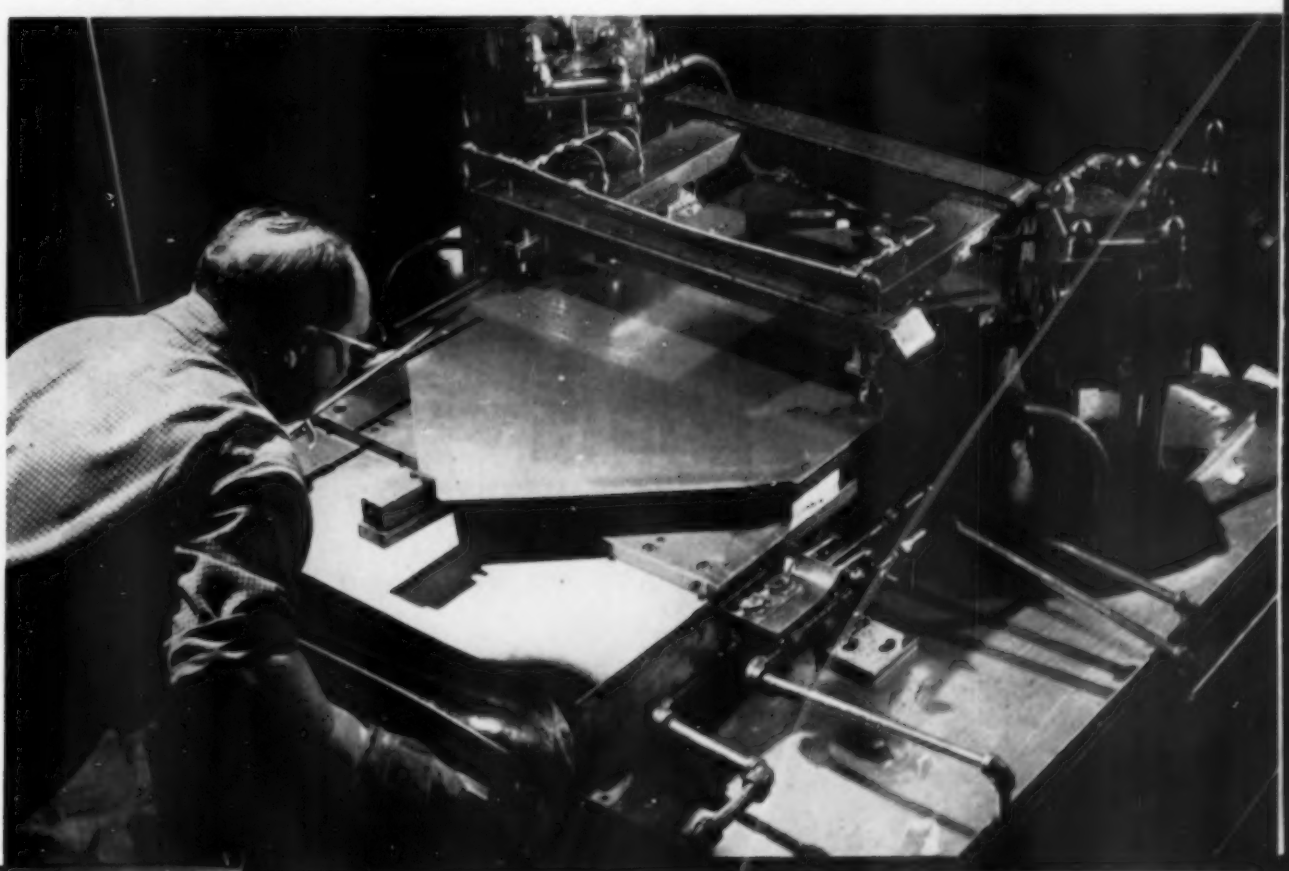
But it was not until we finally demonstrated that good old plain commercial-temper steel would meet all the end-use requirements that our body-forming problems were completely solved. After the sizing operation, the inside diameter of the base is trimmed on a conventional press.

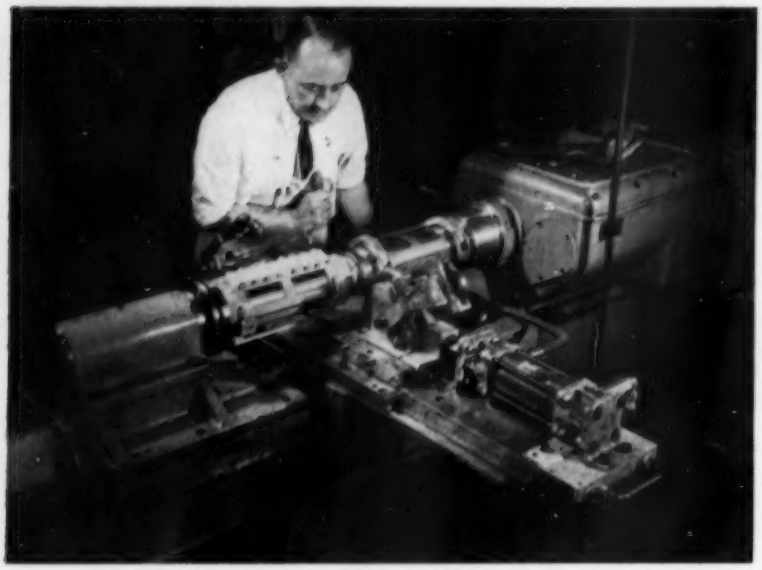
Finally, the body is trimmed to length and a second coat of phenolic varnish applied both inside and out.

We had considerable difficulty in trimming the body. We wanted to trim before it was assembled due to the fact that if we didn't there would be certain operations which would require baking of the phenolic varnish after assembly which would be harmful to the polyethylene seal.

ALTHOUGH the tolerances here are fairly open, the problem was to produce bodies with a uniform length. We tried a number of gadgets that would make "Rube Goldberg" happy before we came up with the solution. Here again we made use of our old friend, the common engine lathe, with a bit of tooling and fixtures designed to hold the body on a mandrel. We have a cutter which more or less reproduces the action of a slitter as we trim the body to length.

Milling machine simultaneously cuts two trapezoidal reliefs in the blank as first step in making a spiral-wrapped case.





A conventional engine lathe with special tooling adapting it to production requirements separates the rolled blank into two partly formed cartridge case bodies.

While the irregular hexagonal blank was undergoing its metamorphosis into the two finished bodies, the base was being machined. Our machining is done on matched sets of conventional 6-spindle chuckers in only two operations. The first operation on the forged base is on the threaded side, which is completely machined. The second operation is on the opposite side where we machine the counterbore, ream the primer hole, and drill the two wrench holes. The machining of the base is completed in these two operations in approximately thirty seconds.

We use two automatic paint spray booths. One is for application of the second coat of phenolic varnish on the inside of the body and the second for coating the outside. During the application of varnish to the exterior of the body, all the component parts for fabrication of one case are hung on a single spindle.

FOR assembly we use the second piece of special equipment in our entire line, designed and built especially for use on this cartridge case. It is an air-driven unit using 150 pounds of torque applied to the nut. There are two operators—one makes the preassembly and the other places it in the assembly fixture, applies the torque, and places the assembly on the conveyer line. Two operators can assemble approximately 300 cartridge cases an hour.

These are the essential operations involved in making a spiral-wrapped cartridge case. There are a few tricks to it, but we think we have reduced it to a basic, simple, metalworking operation. There really is no mystery in this kind of cartridge-case manufacture.

Since our first pilot lot was accepted, none of the changes we have made has been of a major nature—just improvements in our production operations. The new twist in cartridge cases is really only two years old, and it has proved itself to be satisfactory. I would like to sum up some of the advantages:

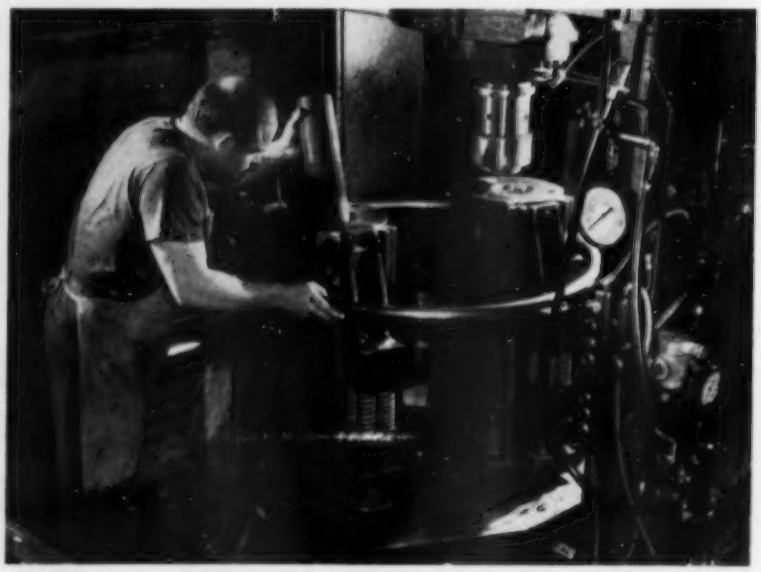
After 3½ years of development, we can turn out a serviceable item which is competitive in cost to the drawn case. New developments in design will ultimately lower costs and further reduce the weight.

TOTAL outlay required to set up a 105-mm. spiral-wrapped cartridge-case line is estimated as one-quarter to one-third that required for the conventional cartridge-case line. Work now being done on new design will be reflected in further reduction of the capital expenditure.

From the experience thus far gained, we estimate that approximately six to eight months would be required to set up a 105-mm. spiral-wrapped line through the pilot-lot production stage. This time period is based upon utilizing to full advantage conventional rather than special single-purpose equipment.

The spiral-wrapped cartridge case, due principally to its being employed on low-velocity weapons, permits the use of materials and equipment that are far less critical than those required on conventional case lines.

An ordinary 200-ton arbor press, modified for quantity production with two dies, is used to size partially made cartridge cases under 150-tons' pressure.



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New Departure split inner ring bearings are separable, facilitating cleaning, inspection and assembly into the engine. They carry heavy thrust loads from either direction and will also support major radial loads.

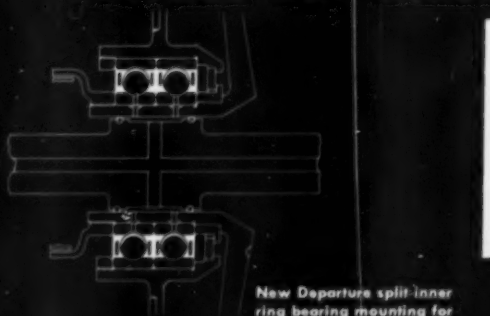
Research develops aircraft bearings for extreme speeds and temperatures

With jet aircraft flying higher and faster than ever before, ball bearings are being called on to meet increasingly severe conditions. For example, bearings that support the turbine wheels are subjected currently to temperatures up to 500° F. at high speeds and heavy thrust loads.

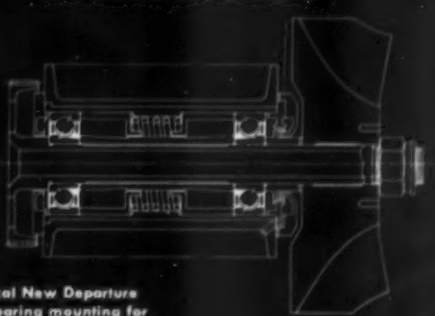
Anticipating still greater demands in the future, New Departure's Aircraft Research Program is already developing bearings for operational speeds of over 100,000 rpm and temperatures moving up towards 1000° F.

Typical of the bearings used in jet engines are New Departure's split inner ring types. These bearings are giving satisfactory performance in production engines today at extremely high speeds and heavy thrust loads. Write for full details.

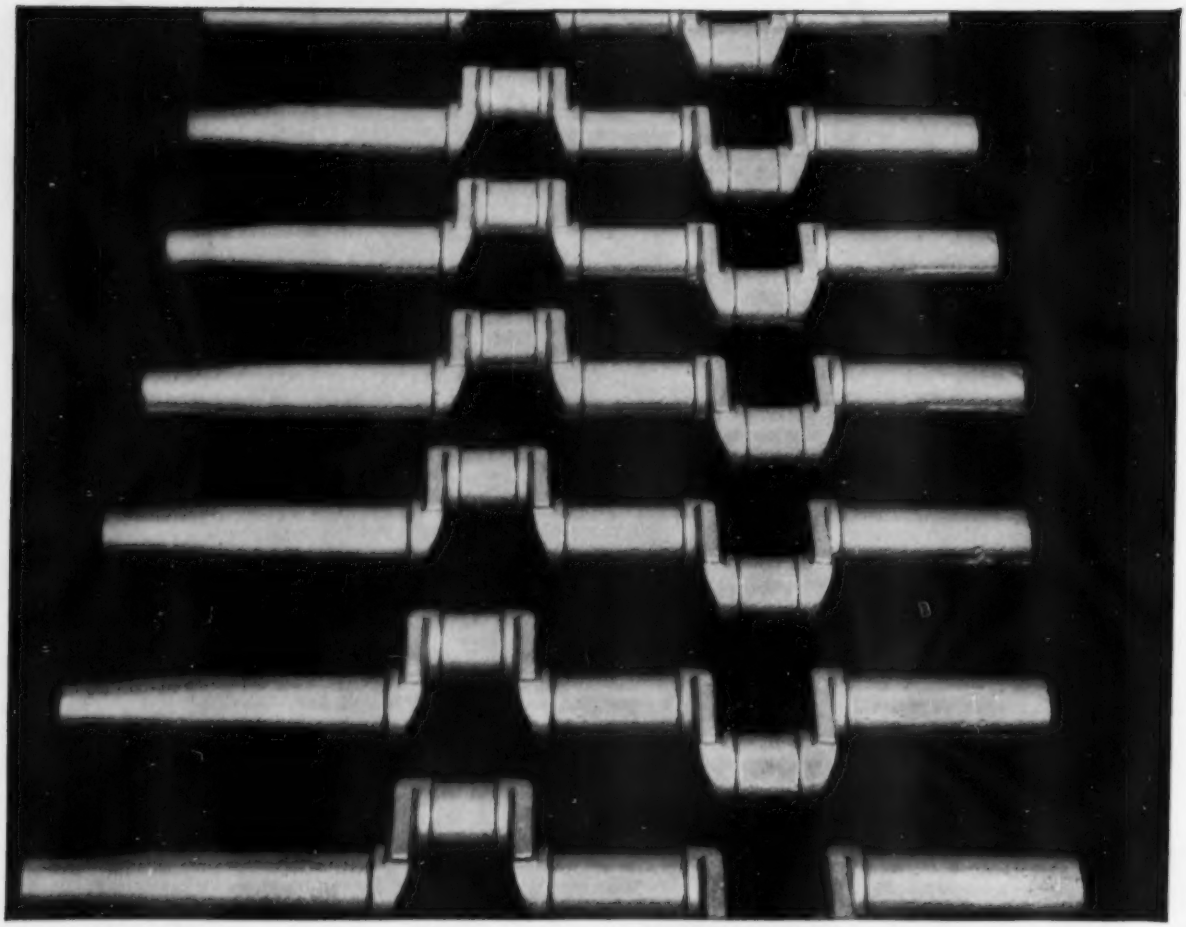
TYPICAL JET AIRCRAFT APPLICATIONS



New Departure split inner ring bearing mounting for jet engine mainshaft



Typical New Departure ball bearing mounting for alternator drive power turbine



Ductile Cast Iron meets a variety of demands. These crankshafts utilize the 80-60-03 type, with the following typical range of properties: Tensile strength 90/110,000 psi, yield strength 60/75,000 psi, elongation 3/10%, hardness 200/270 BHN. Strong as-cast, tough and easily machinable. Also responds readily to flame or induction hardening. A carbidic, abrasion-resisting surface may be obtained by casting it against a chill.

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NOVEMBER-DECEMBER 1955

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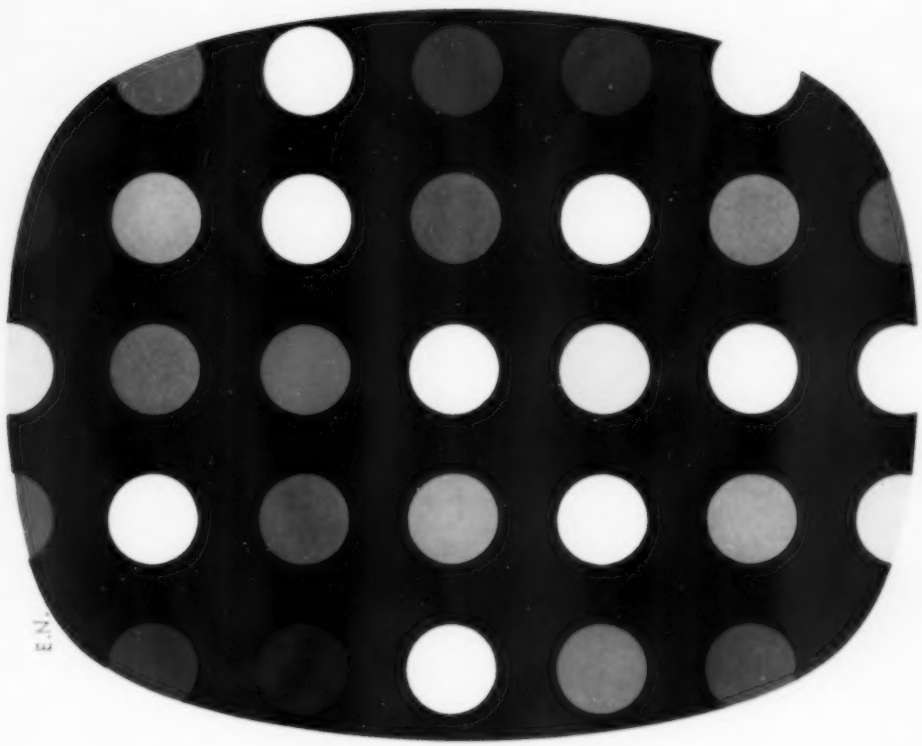

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